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REPORT TO CONGRESS

ENVIRONMENTAL PROTECTION AGENCY

FEBRUARY 1976

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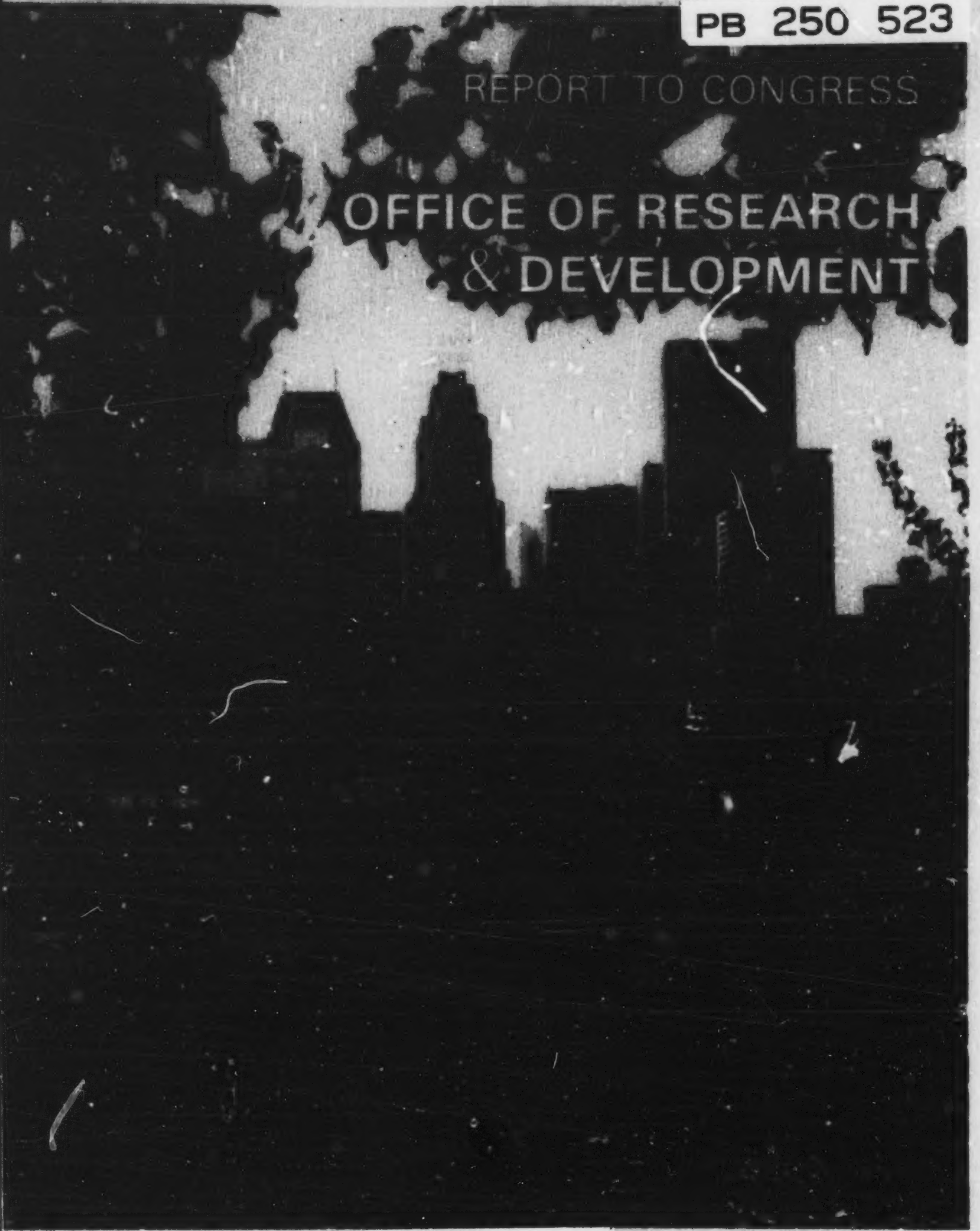

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16. ABSTRACT

This report represents the first attempt by the Office of Research and Development (ORD) to present a 5-Year overview of ORD's research program, priorities and trends. The report will be updated annually. This overview is broken into ORD's five major programs which are: Health and Ecological Effect; Industrial Processes; Public Service Activities; Monitoring and Technical Support; and Energy/Environment. ORD's working agreements with other Federal Agencies are also briefly described. In the near-term ORD has given priority to strengthening the Health and Ecological Effects Program. Another priority area is the Industrial Processes Program where pollution control technology R&D is needed if the 1985 Water quality goals are to be more closely met. Emphasis will also be placed on monitoring and quality assurance R&D which support Agency regulatory actions.

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ENVIRONMENTAL RESEARCH OUTLOOK
FY 1976 through 1980
Report to Congress

Prepared by the
Office of Research and Development
U.S. Environmental Protection Agency
Washington, D.C. 20460

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PREFACE

Prudent environmental management must rest on a sound technical and scientific basis. The development of such a base depends on a strong, viable and timely research effort. I strongly believe that EPA's research must be both anticipatory as well as responsive to the needs of an Agency whose mandate is to restore, enhance and protect the quality of the environment.

This document represents the first attempt by the Office of Research and Development to present a 5-Year overview of ORD's research program, priorities and trends. We have attempted to raise issues and identify where we see environmental problems and priorities occurring. By projecting beyond the next budget year, I hope that the document will initiate a dialogue with enough lead time to build a more meaningful program.

Moreover, I recognize that this is a first attempt and that as such, suffers from the usual weaknesses or deficiencies that are associated with being a first. In addition to substantive criticisms of the projected research program, I invite your comments and suggestions to improve subsequent versions of this document.

Wilson Talley
Wilson K. Talley
Assistant Administrator
Office of Research and Development

U.S. Environmental Protection Agency
Environmental Research Outlook
FY 1976-1980

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PART I

Environmental Research Outlook

The U.S. Environmental Protection Agency (EPA) 'was created by Presidential order in December of 1970. This order brought together 15 programs scattered among several Federal Government agencies to mount a coordinated attack on environmental problems. These problems include air and water pollution, solid waste management, pesticides, water supply, radiation, noise and toxic substances.

EPA must maintain and enhance environmental quality in a way that is consistent with other national goals. Functions performed by EPA include: setting and enforcing environmental standards; researching the causes, effects and control of environmental problems; assisting states and local governments through a variety of planning and waste treatment facility construction grants; disseminating information on environmental problems and solutions; demonstrations;educating the public; demonstrating; demonstrations of how to protect and enhance the environment; and providing of technical assistance in the solution of environmental problems.

In support of the Agency's mission the Office of Research and Development (ORD) conducts a comprehensive and integrated research and development (R&D) program to provide:

- The scientific and technical base for reasonable standards and regulations.
- Standardized methods to measure and assure quality control in programs to assess environmental quality, implement regulations and enforce standards.
- Cost-effective pollution control technology and incentives for acceptance of environmentally sound options.
- Scientific, technical, socio-economic and institutional methodologies needed to judge environmental management options and balance these options against competing national needs.

ORD's research is supplemented by general scientific and technical research in other federal agencies, colleges and universities and elsewhere. ORD also supports the Agency's involvement in many international organizations with mutual environmental R&D concerns.

More general functions of ORD include: (1) maintainence of inhouse expertise capable of quickly responding to emergencies and giving expert consultation and testimony when necessary; (2) sharing the results of environmental R&D with a wide range of individuals, groups, and agencies in ways that are meaningful and practical; and (3) giving expert scientific and technical assistance to other EPA officies to help them formulate environmental policy.

What follows is a report on the first five-year Research Plan. It generally describes ORD's projected research program for the FY 1976 - FY 1980 period including its rationale, resource needs, and priorities. The report will be updated yearly.

ORD ORGANIZATIONAL AND PROGRAM STRUCTURE

The research program, of necessity, is multidisciplinary and multimedia in nature. It is multidisciplinary because the R&D program covers virtually every EPA responsibility and provides support to each of EPA's program and regional offices. It is multimedia because correction of one pollution problem can result in other pollution problems if care is not taken (e.g., emissions prevented from polluting the air have the potential to become a water pollution or land degradation problem).

ORD's program is also multimedia because good management practices require that unnecessary duplication of effort, facilities or expertise be avoided. As such, ORD is divided into four offices that operate along functional lines (see Figure 1).

The R&D program itself is divided into five programmatic areas as shown in Table 1. These are divided further into subprogram areas. Part II of this report provides a detailed description of each subprogram.

ORD's ongoing activities supporting immediate operational requirements of EPA are in the Office of Monitoring and Technical Support (OMTS). These activities include: development and demonstration of monitoring systems; quality control of pollutant measurement and monitoring techniques (quality assurance); technical information dissemination; and technical support services. While this office provides central planning for technical support, such support is given to EPA by other ORD offices/laboratories as appropriate.

Figure 1. ORD Organizational Chart

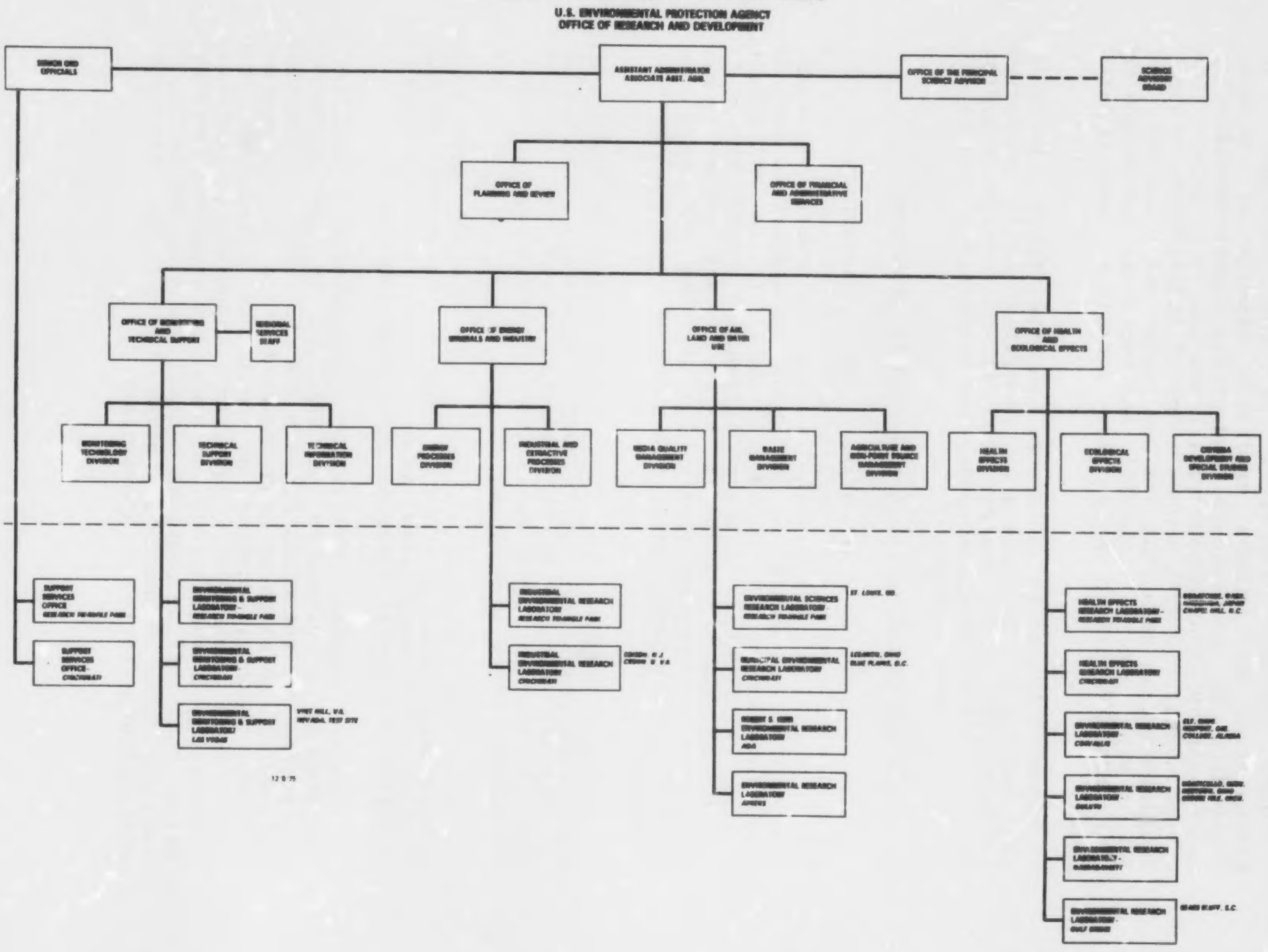

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Table I. ORD Program Structure

- Health and Ecological Effects Program
    - Health Effects
    - Ecological Processes and Effects
    - Transport and Fate of Pollutants

- Industrial Processes Program
    - Mineral, Processing, and Manufacturing
    - Renewable Resources

- Public Sector Activities Program
    - Waste Management
    - Water Supply
    - Environmental Management

- Monitoring and Technical Support Program
    - Monitoring Techniques and Equipment Development
    - Quality Assurance
    - Technical Support

- Energy/Environment Program
    - Health and Ecological Effects
    - Extraction and Processing Technology
    - Conservation-Utilization Technology Assessments

Research activities for longer-term requirements are carried out by the three other offices.

The Office of Health and Ecological Effects (OHEE) is responsible for determining the human health and ecological effects of pollution.

The Office of Energy, Minerals, and Industry (OEMI) is responsible for assessing, developing, and demonstrating technology to abate pollution from industrial point sources. This office also plans and administers a comprehensive federal energy and environmental research, development, and demonstration program.

The Office of Air, Land, and Water Use (OALWU) is responsible for: research, development, and demonstration of environmentally sound water supply systems and waste management activities (including municipal wastewater treatment and hazardous and other solid waste management systems); control of pollution from agriculture and forestry (renewable resource industries); transport and fate of pollutants in the environment; and area-wide environmental management strategies.

The relationship of the four Offices and fourteen subject-related research subprograms are shown in Table 2. Note that the "planning responsibility" for any subprogram is generally in one Office while the "implementation responsibility" is often the responsibility of several offices. The term, "planning responsibility," refers to the establishment of specific major objectives, their relative priorities and resource levels for each. The term, "implementation responsibility," refers to development of the particular approach in pursuit of each objective and supervision of required work.

The ORD mission is achieved through the combined efforts of about 1,800 technical and support personnel. More than 60 different professional disciplines and specialities located throughout the Nation in 15 laboratories and the Washington, D.C. headquarters are included. ORD's budget in FY 1976 is approximately $250 million.

Projects are conducted: (1) through inhouse R&D by ORD scientists and engineers, (2) through a large extramural grant and contract program in cooperation with colleges and universities, industrial organizations, research institutes, and state and local governments and (3) through interagency agreements with other federal agencies.

Table 2. Relationship Between ORD Organizational and Program Structure

Subprogram Area	Planning (P) and Implementing (I) ORD Offices			
	OHEE	OEMI	OALWU	OMTS
Health Effects	P I		I	I
Ecological Processes and Effects	P I		I	I
Transport and Fate of Pollutants			P I	I
Mineral, Processing, and Manufacturing	I	P I	I	
Renewable Resources			P I	
Waste Management			P I	
Water Supply	I		P I	I
Environmental Management			P I	
Monitoring Techniques and Equipment Development			P I	P I
Quality Assurance	I			P I
Technical Support				P I
Health and Ecological Effects/Energy	I	P	I	I
Extraction and Processing Technology/Energy		P I		
Conservation, Utilization and Technology Assessments/Energy		P I	I	

In FY 1976, about 25 percent of ORD's funds are used for inhouse activities; about 55 percent for grants and contracts; and about 20 percent for interagency agreements.

RESEARCH APPROACHES

EPA's overall research program must support the mission of a regulatory agency. Specific research objectives and priorities derive from objectives and priorities that EPA establishes in fulfilling its total legislative mandate. Accordingly, the research program is "mission oriented" with emphasis on production of timely and quality outputs, i.e., research results that are directly useful to environmental decision-makers, regulatory officials and polluters.

The following guidelines were used to develop a comprehensive research program to support EPA's mission:

- Emphasis is given to research designed to protect human health and welfare, including the integrity of natural ecosystems. In this category is research assessing both short- and long-term low-dose effects of pollutants on human health, exposure to potential health hazards in a variety of ways, interactive effects of pollutants on both health and ecological systems, transport and fate of pollutants and technologies for control of toxic or hazardous pollutants.

- A reasonable balance must be maintained between responsiveness to immediate technical support and continuing information needs of EPA, and longer-term research to meet future and emerging environmental problems in developing and evaluating environmental policy.

- Both dollar and manpower resources should be reserved for short-term technical support.

- Deliberate attention should be given to timely and effective dissemination of technical information and to technology transfer.

- An adequate program of quality assurance for EPA's pollution monitoring and measurement activities must be maintained.

- Environmental management methods and technology development and demonstration efforts in pollution abatement and environmental restoration should attempt to:

  (a) Stimulate, assess and support development of technically and economically feasible technological solutions, including control technology (e.g., stack gas scrubbers, advanced waste treatment, sludge utilization and disposal, etc.); substitution of alternate, more environmentally acceptable processes and practices (e.g., closed loop systems, biological pest controls, etc.); and materials and energy conservation measures (e.g., recycling, soil erosion control, water reuse, more efficient combution processes, etc.);

  (b) Identify and foster improved management techniques that improve environmental quality through nonstructural and nontreatment methods, thereby reducing required capital costs (e.g., change farming methods, institute profitable industrial process changes and modify land use patterns);

  (c) Identify and evaluate institutional approaches to implement technological options (e.q., improve regulatory approaches, provide economic incentives or sanctions, etc.).

- Solutions to environmental problems that minimize costs, energy usage and undesirable transfer of pollutants to other media should be emphasized.

- Comprehensive environmental/socio-economic assessments will continue to be supported, and integrated wherever possible into research programs. Scientific and technical information should be presented in a way that allows risks, benefits and costs to be compared, particularly to guide decisions on what pollution levels are tolerable in the environment.

- Methodological tools should be developed for assessing environmental problems, measuring effectiveness of environmental controls and predicting consequences of alternative pollution control strategies.

- Flexibility to address unforeseen problems must be maintained.

While EPA is responsible for developing and refining a comprehensive federal research program for environmental protection, actual research is carried out by many others. These include, but are not limited to: EPA laboratories; other government agencies either through funded interagency agreements or through coordination with individual programs; and the user community, including State and local governments, industry and colleges and universities.

An example of its coordination role is ORD's Energy and Environmental Program. EPA was directed by the Congress to coordinate an energy and environmental research, development, and demonstration program to ensure that environmental factors were considered along with activities to increase the Nation's production of energy. To meet this goal, ORD undertook the responsibility for managing and integrating the efforts of 18 federal agencies in a coordinated federal program. ORD's Office of Energy, Minerals, and Industry administers "pass-through" monies to other federal programs to minimize duplication of effort and ensure efficient use of resources.

AUTHORITIES AND CONSTRAINTS

Legislative

In developing the research program, certain authorizations and constraints must be recognized. Key among these are the legislative authorizations and mandates. The major pieces of legislation under which EPA operates contain broad, essentially all-encompassing authorizations for research and development on the "control, prevention, abatement, effects" of pollution. Overlapping these broad authorizations are many specific authorizations or even mandates that relate to work on specific problems (e.g., acid mine drainage, lake restoration, etc.), or that authorize certain special types of funding for eligible grantee or contractor organizations. In addition to these complexities, there are other mandates for R&D that derive from implementation dates for major environmental protection standards and regulations. These, of course, require concentrated R&D efforts.

The broad legislative authority for EPA's programs comes primarily from nine separate Acts: The Clean Air Act (CAA), The Federal Water Pollution Control Act (FWPCA), The Safe Drinking Water Act (SDWA), The Solid Waste Disposal Act (SWDA), The Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), The Public Health Service Act (PHSA), The Noise Control Act (NCA), The Marine Protection Research and Sanctuaries Act (MPRSA), and The National Environmental Policy Act (NEPA). The most relevant sections that give authorizations to ORD's program are described and identified in Table 3.

In addition to the direction of authorizing Acts, other Congressional mandates are often found in Appropriations Reports. In FY 1976, for example, the Congressional Appropriations and Conference Reports contained specific guidance for R&D on: assessment of the potential environmental, social, and economic impacts of the proposed concentration of power plants in the lower Ohio River Basin; and an assessment of environmental factors having an adverse impact on the Chesapeake Bay, including establishment of data collection and monitoring systems, determination of governmental units that have management responsibility and how such responsibility can be structured so that communication and coordination can be improved among all concerned parties. These requests place specific research demands upon ORD.

ORD Commitments

In formulating its research program, ORD must also remain aware of special commitments made for interagency cooperation and intraagency support. These commitments and how ORD interfaces with other federal agencies are discussed in Appendix A.

Resource Constraints

The economic climate in recent years has necessitated restrained governmental spending. It is likely that this need for fiscal restraint will continue throughout the period covered by this program plan. Accordingly, this plan reflects a decision to keep total resource (dollars and positions) levels within realistic bounds. This approach will provide for the essential research and development program required to meet the Nation's current and anticipated environmental and development needs. This plan does not, however, reflect a level of resources sufficient to fully perform all anticipatory research and development which would allow ORD to get a headstart on

Table 3. Authorizing Legislation for EPA Program

Legislation	General R&D Authorization	Sections
Clean Air Act (CAA)	The Clean Air Act, as amended, directs the Administrator to establish a national research and development program for the prevention and control of air pollution and shall conduct, and promote the coordination and acceleration of research investigations and experiments relating to the causes, effects, extent, prevention, and control of air pollution.	103, 104, 108, 109, 111, 112, 119, 202, 211, 303, 312, 313
Federal Water Pollution Control Act (FWPCA)	The 1972 amendments establish research programs for the prevention, reduction, and elimination of pollution in navigable waters of the United States. Specifically, the agency must render technical advice, and conduct research, investigations, experiments, training, demonstrations, surveys, and studies; establish advisory committees to evaluate research progress and proposals; establish a water quality surveillance system to monitor the quality of navigable waters and initiate studies measuring the social and economic costs and benefits of water pollution control activities. The Administrator must establish field laboratories and research facilities, investigate the harmful effects of pollutants on the health and welfare of persons, and make a comprehensive study of the pollution of the Great Lakes. Oil spills and thermal discharge must be investigated. A major research development and demonstration effort is required to develop control technology and management methods necessary to eliminate the discharge of pollutants into waterways.	
Safe Drinking Water Act, (SDWA)	The Administrator may conduct research, studies, and demonstrations relating to the causes,diagnosis, treatment, control, and prevention of physical and mental diseases and other impairments of man resulting directly or indirectly from contaminants in water, or to the provision of a dependably safe supply of drinking water.	Sec. 1442, 1444
Solid Waste Disposal Act, (SWDA)	This Act directs the Administrator to conduct and cooperate research efforts relating to any adverse health and welfare effects of the release into the environment of material present in solid waste, and methods to eliminate such effects; the operation and financing of solid waste disposal programs; the reduction of the amount of such waste and unsalvageable materials; the development and application of new and improved methods of collecting and disposing of solid waste and processing and recovering materials and energy from solid wastes.	204, 205, 208

Table 3 (Cont.)

Legislation	General R&D Authorization	Sections
Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA)	The Administrator shall undertake research to carry out the purposes of the Act, giving priority to the development of biologically integrated alternatives for pest control. The Administrator shall formulate a national plan for monitoring pesticides and undertake activities in suppor of it.	20, 27
Public Health Service Act (PHSA)	The Administrator, under the Public Health Service Act, has authority to determine levels of radiation in the environment, their pathways to man, and the health risks from these doses. EPA is cooperating in a study of health effects of radiation along with monitoring the environment (particularly around nuclear power plants) to calculate the population's total exposure to various forms of radiation. EPA is also conducting a complete review of present radiation standards, along with an assessment of the entire nuclear fuel cycle.	301
Noise Control Act (NCA)	This law enables the Administrator to establish a comprehensive research program in the area of noise. Sucha a program enables EPA to undertake the necessary investigations into the health effects of noise under varying conditions of magnitude, duration, background, etc. Such information is currently lacking in most areas. This program examines those technological aspects of noise control and abatement not currently being treated.	Sec. 14, 19
Marine Protection, Research and Sanctuaries Act (MPRSA)	The Administrator in coordination with the Secretary of Commerce and the Coast Guard shall initiate a comprehensive and continuing program of monitoring and research regarding the effects of the dumping of material into the ocean water or waters which ebb or flow into the Great Lakes and report the effects not less frequently then annually. The Administrator is responsible for offering consultation to the Secretary of Commerce on the possible long-range effects of pollution, overfishing and man-induced changes of ocean ecosystems.	201, 202
National Environmental Policy Act (NEPA)	The National Environmental Policy Act October of 1969 (NEPA) requires Federal Agencies to prepare environmental impact statements (EIS) for legislative proposals and for other "major federal actions that significantly affect the quality of a human environment." In preparing these EIS's, a Federal agency must consult with other agencies having jurisdiction by law or special expertise over such environmental considerations. Since EPA's purview is the total environment, it must be consulted for most EIS's.	102(2)(C)

newly emerging problems or on improving the quality of existing abatement and monitoring methods and environmental quality and effects data.

Of course, ORD will draw to the maximum extent possible on research being funded and conducted by other government agencies, industry and foreign countries. ORD is continually exploring other ways to obtain and transfer data and technology.

Personnel limitations have had a similar constraining effect. Recently, major dollar resources were provided to EPA for a multiagency environmental research program to parallel and lead ERDA's program of energy development. While funds were provided, personnel to staff this multiagency energy program had to be drawn from ORD's existing staff.

Over the past few years, the staff available for the research program has continually diminished (see Table 4). During the same period, new problem areas have emerged that require personnel with different skills or increased effort. As a result, ORD has shifted staff and/or contracted out greater portions of the work.

In FY 1975, there was a major reexamination of ORD's mode of conducting its operations that has continued in FY 1976. While this has resulted in a shift of personnel from administrative duties to direct research functions, there remains a skill mix problem. The substantial funding increase for the environmental and energy program in FY 1975, coupled with a decline in staff, has required a further shift in the balance between inhouse and extramural work toward the latter.

Accordingly, to address personnel resource needs, EPA/ORD is conducting an in-depth review of its research needs in relation to the skill mix and staffing levels given current and anticipated research requirements. The study will include a plan to alter the technical skill mix over a period of years with a minimal influx of new positions targeted at specific skills needed. ORD will make adjustments by filling vacancies as they occur with specific skills that are needed.

Table 4. ORD Authorized Positions FY 1973 - FY 1976

	FY 1973	FY 1974	FY 1975	FY 1976
Full Time Permanent	1897	1842	1753	1752
Reimbursable	134	113	112	82
TOTAL	2031	1955	1865	1834

PROGRAM PRIORITIES AND TRENDS

The proposed resource needs for ORD's program are presented in Table 5. The budget is broken out by research program and appropriation. These programs are individually described in full detail in subsequent sections. FY 1975 funding is also shown to serve as a base. Further, two budget options are presented in Tables 5a and 5b to show a level budget for FY 1977 and beyond.

Table 5 shows that over the five-year period FY 1976-FY 1980, priority has been given to strengthening the Health and Ecological Effects Program to develop the data base needed to support EPA's regulatory activities. Recent judicial decisions require EPA to develop more detailed information on effects of pollutants.

Another priority area is the Industrial Processes Program. The proposed "spike" increase in resources for industrial pollution control technology R&D is needed if the approaching 1985 water quality goals are to be more closely met. This "spike" increase in resources will ensure that full-scale demonstrations of control technology required by FWPCA can be completed for those industries having toxic effluents most harmful to the environment. ORD will continue to rely heavily on industrial expertise and resources for major contributions to develop the needed new technology.

Priority is also being given to the Monitoring and Technical Support Program. Like effects work, research in monitoring and quality assurance is motivated by the need for better data to support Agency regulatory actions. Credibility of EPA's action depends greatly on the quality of pollutant measurement and monitoring data. ORD must

Table 5. Projected ORD Resource Needs ($M)*

Program Area	FY 1975	FY 1976	FY 1977	FY 1978	FY 1979	FY 1980
Health and Ecological Effects	64	72	67	88	90	92
Industrial Processes	23	20	20	54	60	32
Public Sector Activities	28	30	28	37	37	38
Monitoring and Technical Support	19	27	27	35	37	37
Other (ORD Program Support & Management ADP, etc.)	9	7	7	7	8	8
Subtotal Base ORD	143	156	149	221	232	207
Energy/Environment	134	100	96	118	121	120
Total ORD Program	277	256	245	339	353	327

* Does not include Agency program management costs charged against R&D appropriation.

Table 5a. Option A: ORD Level Budget with "Spike" Increase ($M)*

Program Area	FY 1975	FY 1976	FY 1977	FY 1978	FY 1979	FY 1980
Health and Ecological Effects	64	72	67	56	55	64
Industrial Processes	23	20	20	54	60	32
Public Sector Activities	28	30	28	20	19	27
Monitoring and Technical Support	19	27	27	24	24	30
Other (ORD Program Support & Management, ADP, etc.)	9	7	7	7	7	7
Subtotal Base R&D	143	156	149	161	165	160
Energy/Environment	134	100	96	84	80	85
Total ORD Program	277	256	245	245	245	245

* Does not include Agency program management costs charged against R&D appropriation.

Table 5b. Option B: ORD Level Budget without "Spike" Increase ($M)*

Program Area	FY 1975	FY 1976	FY 1977	FY 1978	FY 1979	FY 1980
Health and Ecological Effects	64	72	67	69	69	69
Industrial Processes	23	20	20	16	16	16
Public Sector Activities	28	30	28	32	31	31
Monitoring and Technical Support	19	27	27	31	32	32
Other (ORD Program Support & Management, ADP, etc.)	9	7	7	7	7	7
Subtotal Base R&D	143	156	149	155	155	155
Energy/Environment	134	100	96	90	90	90
Total ORD Program	277	256	245	245	245	245

* Does not include Agency program management costs charged against R&D appropriation.

extend its activities in this area, especially if EPA is to satisfy requirements of drinking water legislation and of FWPCA. This program will experience gradual growth over the next five years.

In addition to ORD's projected resource needs shown in Table 5, two options are presented on the boundary condition that the total resources for FY 1977 and beyond will remain at the FY 1977 level. The option presented in Table 5a provides the resources needed for control technology R&D if the goals in FWPCA are to be more closely met by industrial dischargers. In order to accommodate the "spike" increase for the industrial program within the constraint of a level budget for FY 1977 through FY 1980, significant reductions in other ORD programs would have to be made. Specifically, research on health and ecological effects, transport and fate of pollutants, waste management and water supply would have to be cut back. Moderate reductions would be required in monitoring techniques and equipment development. Additional reductions must also be made in the energy/environment program, probably in the control technology area which would stretch out the development of this technology.

Again, within the level resource constraint, Option B which is showin in Table 5b, trades off the "spike" increase for industrial pollution control technology R&D for increases in water supply, monitoring and technical support, and health and ecological effects research. Without the "spike" increase, there will not be significant advances in control technology to impact the achievement of the 1985 water quality goals. Therefore the industrial program is stretched out even further being reduced from $4 to $10 million to provide resources in other areas. Again, such program increases can only be accomplished by some reduction in the energy/environment program.

Internal priorities of several programs will shift over the next five years. These shifts are described in greater detail in Part II. But before the detailed program descriptions are given, all the interconnections of ORD's efforts must be understood.

ORD PROGRAM OVERVIEW

ORD's research, development and demonstration activities must be viewed as an interrelated set. ORD's "mission-oriented" or "problem-oriented" approach to specific problems often requires coordination of ORD offices.

For example, the total ORD effort can be described as an interconnected system of research pursuits with six major elements as indicated in Figure 2. These elements are: (1) environmental loading and contamination associated with human activities and natural sources; (2) environmental processes that result in pollutant transformation, transport, and removal processes; (3) pollutant identification, characterization and measurement; (4) development of measurement and monitoring methods; (5) determination of health, ecological and other welfare effects; and (6) development of alternate control technologies and management methods to affect environmental enhancement and restoration.

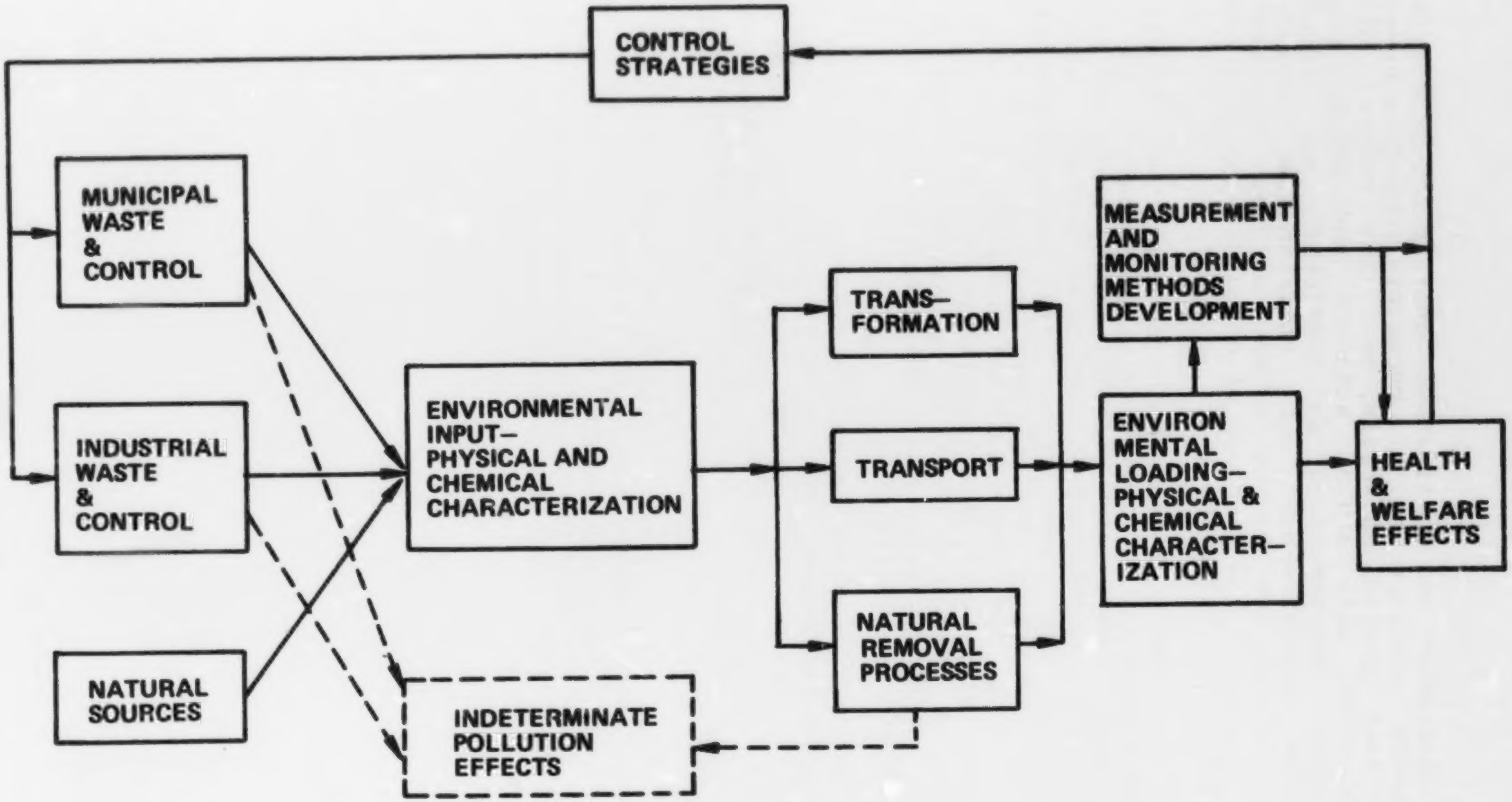
The environmental loading element relates to natural and man-made "sources." These latter sources can be characterized as stationary or mobile, point (i.e., industrial) or nonpoint (i.e., agricultural) and other kinds of human, or more specifically, municipal activities. Emissions and wastes from each source must be characterized by physical and chemical properties in the process stream and at the source output.

Environmental loadings are subject to complex physical and chemical transformation, transport and removal processes. These interactions must be assessed and understood for environmental pollutants to be efficiently controlled.

Capabilities to characterize environmental contaminants (i.e., determine their chemical composition) and measure ambient concentrations must be developed. Effects research depends critically on the availability of effective characterization and monitoring techniques for all forms of wastes including gases, liquids, solids and energy.

Overall assessment of health, ecological, and other welfare effects must be figured on concentrations, as well as physical properties and chemical composition, of the environmental pollutant observed. The element of environmental loading must provide the necessary

Figure 2. FLOWCHART OF ENVIRONMENTAL R&D


CONTROL STRATEGIES
MUNICIPAL WASTE & CONTROL
INDUSTRIAL WASTE & CONTROL
NATURAL SOURCES
ENVIRONMENTAL INPUT— PHYSICAL AND CHEMICAL CHARACTERIZATION
INDETERMINATE POLLUTION EFFECTS
TRANS— FORMATION
TRANSPORT
NATURAL REMOVAL PROCESSES
MEASUREMENT AND MONITORING METHODS DEVELOPMENT
ENVIRON MENTAL LOADING— PHYSICAL & CHEMICAL CHARACTER— IZATION
HEALTH & WELFARE EFFECTS

quantitative and qualitative input in the proper format to assess exposure of all receptors including humans, other animals, plants, materials, etc. The effects element is concerned with acute, subacute and chronic effects and effects characterized as reversible and irreversible. Since establishment of environmental standards and regulations are reasons for much of this research, close coordination and feedback of effects research and abatement methods R&D are essential.

The last element concerns itself with identification and development of cost-effective approaches to pollution control. Obviously, relevant costs, risks and benefits of feasible control options must be evaluated. Such control measures can range from "hard" technology modifications (e.g., add-on devices, process change, resource recovery, etc.) to socio-economic implementation instruments (i.e., incentives, land use regulations, etc.). Finally, a quality assurance effort of monitoring methods is required for implementation and effective enforcement of any standard or regulation.

ORD's 14 research subprograms are integrated into this kind of framework. No one R&D effort can stand alone, i.e., most of ORD's outputs contain interrelated inputs of more than one subprogram. The mission of EPA requires such and the nature of solutions to environmental problems demand no less.

Part II gives a detailed look at each of the subprograms grouped within the program structure in Table 2. For each subprogram, there will be: a description of the research effort and an identification of both near-term and five-year outputs. A broad overview of each program is also given.

PART II

Program Descriptions

HEALTH AND ECOLOGICAL EFFECTS PROGRAM

Overview

The Health and Ecological Effects Program is fundamental to EPA's responsibility to set criteria, standards, and guidelines to protect and enhance environmental quality. Scientific information on human health effects of pollutants and ecosystem structure, function and parts is essential in development of environmental quality standards and effective pollution control strategies. The link between existence of a damaging pollutant and the way it got into the environment must also be understood by policy-makers. That is why research on pollutant transport and fate is essential.

The Health and Ecological Effects Program provides information for establishment and reevaluation of water quality criteria, air quality criteria, ocean disposal criteria, pesticide registration guidelines, effluent standards for toxic and hazardous materials and radiation standards.

Studies will continue in the Health Effects Subprogram on pollutants with set ambient air quality standards to enable a continuing reevaluation of such standards. Such research will gradually be reduced over the next five years while research (i.e., developing dose-response information) on noncriteria pollutants, especially sulfates, nitrates, and respirable suspended particulates will be accelerated. Research on environmentally-induced carcinogenesis has just begun and will focus on quantitative assessment of environmental levels of carcinogens and associated risk factors. Efforts to identify chronic effects of exposure to specific environmental chemical agents will be expanded. A comprehensive inhalation toxicology and biomedical data base will also be developed to ascertain health risks of emission products from catalytic converter-treated auto exhaust and potential catalyst attrition products such as sulfuric acid; sulfates, carbon disulfide, hydrogen sulfide, palladium, platinum and aluminum oxide.

Health effects research on pesticides will increasingly receive emphasis and will provide necessary support to regulatory and control functions of EPA in regard to risks of pesticides to population groups in general.

Research on chemical substitutes provides scientific information on compounds in current use that EPA considers as potential substitutes for pesticides that have been suspended or cancelled. ORD's activities in this area help the Office of Pesticides Programs (OPP) in implementation of the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) at both federal and State levels.

Research on health implications of land disposal of wastewaters and sludges (e.g., effects of aerosols containing bacteria or viruses) has recently increased and will continue to receive high priority.

A related subprogram, Water Supply, supplements research in the Health Effects Subprogram with additional funds. This research focuses on health effects of contaminants found in drinking water. Details of water supply health effects research are discussed in the Water Supply Subprogram.

The Ecological Processes and Effects Subprogram will gradually broaden its current effort to develop water quality requirements for representative organisms. It will include a greater emphasis on evaluation of whole ecosystems and on developing ecological models with minimal information requirements. However, the need to determine criteria for specific pollutants will continue.

As currently required criteria are developed, resources will shift toward identification of new pollutant problems. Especially emphasized will be development of a theoretical understanding and ability to predict and assess emerging problems, development of ecological criteria for other pollutants and revision, where necessary, of already-established criteria.

Because transformation and fate of a pollutant in an ecosystem is an ecological process, the Ecological Processes and Effects Subprogram not only researches effects of pollutants on ecosystems and their components, but also researches effects of ecosystems on pollutants. Such considerations are important determinants of how quickly pollutants will be transformed into harmless materials, persist and accumulate to dangerous levels or be changed into more harmful materials than the parent substance. That is why research data on the fate, transport, and ecosystem impact of specific pollutants is necessary to support environmental quality criteria development and pesticide registration.

Information on the fate and transport of pollutants in time and space is needed by EPA's regional offices and States to implement standards, basin planning, and waste load allocations. Specific emphasis will be on: transport and fate of metals in soils and plants; coupling nonpoint source loading models to basin water quality models for use in assessing water quality impacts of both nonpoint and point sources; development of pollution loading functions by source with appropriate user manuals; assessment of the air transport and alteration of sulfates on both a regional and global scale; research on the formation and transport of oxidants locally and regionally; and continuation of the St. Louis Regional Air Pollution Study (RAPS).

Emerging problems, such as those of freon and other potentially hazardous substances, will likely receive increased attention. Research will focus on what the long-term pollutant loading capacity of the environment is globally, regionally, and locally; what the likely effects are of different pollutant load levels; and on predictive capability for forecasting local, regional, and global environmental quality under varying pollutant loadings and environmental conditions.

Funds from ORD's Energy/Environment Program supplement much of the research in the Health and Ecological Effects Program. In some cases such funding allows for more intensive research in activities already planned by the base program. In other cases, research activities with a much broader scope are made possible. The comprehensive EPA-coordinated Energy/Environment Program is discussed later.

Another emphasis in the Health and Ecological Effects Program will be on socio-economic assessments. This work will focus on: assessment of health and welfare benefits of pollution abatement; development of methods for predicting and evaluating pollution problems related to exposure; and economic impact assessment. Emphasis in benefit studies is expected to be on pesticides, toxic substances, and drinking water. Ad hoc studies will also be conducted on specific EPA issues as they arise.

Health Effects

Subprogram Description

Environmental health has emerged as a major new research area. EPA is responsible for translating results of this research into effective control policy. EPA's health effects research is carried out by the largest single group of environmental health professionals ever assembled. This program is divided into the following seven major categories:

- Air Exposure

Air pollution has been historically recognized as an environment factor in public health. In its first five years of existence, EPA has continued and expanded air pollution research of its predecessor agencies. Although much remains to be learned, meaningful progress has been made toward understanding the relationships between air quality and public health. The data basis for the existing six ambient Air Quality Standards is being substantially improved and increased emphasis is being given to categories of air pollutants not controlled now. Also, since 70% of our time is spent indoors, emphasis should be given to assessing the health hazards associated with indoor pollutant levels.

- Transportation

Although quite properly a subcategory of Air Exposures,, public health implications of pollutants specifically associated with transportation merit separate attention. Complex interactions of mobile source emissions complicate study of their health effects. Relatively rapid introduction of new control technology and fuel additives further complicates definition of hazards associated with altered emissions. Attention specifically is directed to evaluation of health implications of catalytic devices, the shift toward increased use of diesel-powered vehicles and introduction of synthetic fuels.

- Water Exposures

As with air pollution, public health consequences of water pollution have a long history. Two salient differences exist, however. Man consumes water as he does air, but not continuously. For that reason, polluted water can be treated before consumption, whereas polluted air, for most practical purposes, cannot. Air pollution health research is recent compared to water health research. There are very adequate data for control of microbial water pollution compared to any part of the data base for air pollution control. Finally, a major aspect of water exposure involves use of water for recreational purposes, producing a major interface between health effects and ecological effects research.

- Radiant Energy

Great discrepancy exists between health standards for nonionizing electromagnetic energy exposure in this country and abroad. Large differences in human exposure to electromagnetic energy densities exist. Increased use of the electromagnetic spectrum for communication and potentially for power transmission require improved understanding of nonthermal effects of human exposure to nonionizing radiation.

Increased use of nuclear power generation will require increased fuel reprocessing with tritium and Krypton-85 release into the environment. EPA is continuing health research in this area with research planned to be phased into that of ERDA over the next two years.

- Pesticides

Increased use of pesticides (herbicides, insecticides, rodenticides and fungicides), improved understanding of soil chemistry and development of new plant strains in addition to increased use of fertilizers have revolutionized agriculture. Some pesticides pose serious health hazards for man and accumulation of some pesticides in the environment creates special problems. Another problem arises from the introduction of toxic contaminants during the manufacture of pesticide compounds, e.g., dioxins formed during the manufacture of 2,4,5 - Trichlorophenol.

- Toxic Substances

Modern technology introduces thousands of potentially toxic substances into the environment daily. Their potential effects, such as carcinogenesis or mutagenesis, may require years to become evident. They also can have direct toxic effects. Many of the same techniques used to evaluate toxicity of pesticides are used to test these other toxic substances. In ORD, these two activities are conducted in the same laboratories.

- New Programs

Environmental health research must be adaptable to changing circumstances in a rapidly changing industrialized society. Unifying concepts in environmental medicine and research management are being developed and used to assure responsive, quality health effects research. The three major causes of disease and death are now: chronic respiratory disease, cardiovascular disease and cancer. These three disease categories have multifactorial causes, many suspected to be closely related to environmental factors. For that reason, health research in EPA has a major responsibility to determine what environmental factors have a major role in these three scourges of modern mankind so that these environmental factors can be eliminated or controlled.

Each of the seven aspects of EPA's environmental health research are conducted by problem-oriented scientists who work with other experts to provide data on which to base a comprehensive pollution control policy. More detailed program descriptions along with projected dates for major accomplishments make up the remainder of this section.

Air Exposures

Research information is required to clarify exposure-effect relationships between pollutants and human health for development of a data base to determine whether restricting exposure to particular pollutants is needed to protect health and if so, to what degree exposure should be restricted. For example, in the case of sulfates, nitrates, and other respirable suspended particulates, available information indicates that restricting their ambient concentrations may be necessary. The essential questions about these pollutants relate to the degree of control required. Health effects data for all these pollutants are obtained from direct toxicological, clinical, and epidemiological studies. All three approaches provide a complimentary understanding of the problem: What are the health benefits of reducing pollutant levels?

Among criteria pollutants there are insufficient data on: exposure averaging times; adequacy of existing safety margins; health benefits of meeting the standards and health risks of exceeding the standards. Implementation and adjustment of ambient air quality standards will be influenced substantially by these data.

Among noncriteria pollutants health effects research is primarily directed at developing a data base for sulfates, nitrates, and respirable particulates. There is some evidence that shows possible harmful effects to human health. The goal of this research is to determine exposure-response relationships of these pollutants by themselves and in combination with criteria pollutants.

The epidemiology research is evolving into targeted population studies designed to test hypotheses developed from earlier CHESS (Community Health Effects Surveillance Studies) results. Specific studies on sulfate and nitrate aerosols are in progress. These studies are conducted in: the South Coast Air Basin of California presenting a special problem as use of higher sulfur-containing fuel is increased in an area of high oxidant levels; the Northwestern intermountain region where high sulfate levels occur in conjunction with smelter operations; and in highly industralized areas each of the Mississippi and south of the Great Lakes where the potential exists for large regional sulfate problems arising from long-term transformation and long-range transportation of sulfur oxides, mostly from stationary sources. Population studies have also been initiated in Southern California to refine exposure-response estimates for oxidant effects. These studies allow comparison of sulfate effects in the presence of high oxidant levels with those effects where oxidant levels are relatively low.

Particulate effects will reevaluated in Birmingham in FY 1977 to assess the benefits of improved air quality. The long-term effect of previous high nitrogen oxide levels in Chattanooga will also be reassessed. The complex air pollution problem and large population-at-risk in the Chicago-Gary region will be evaluated. Finally, two new areas of high air sulfate levels will be identified and studies initiated. The Ohio River Valley is the likely candidate for these sites. To improve the basis for a short-term nitrogen oxides standard, a new point source nitrogen oxide area will be identified and studied.

FY 1976 Plan

- Refine estimates of health effects related to short-term nitrogen oxides exposure around point sources.
- Refine the acid sulfate aerosol health impact and impact of trace metals in primary smelter communities.
- Delineate chemical composition and particle size and conduct toxicity screening for selected pollutants.
- Characterize sulfur oxide and oxidant interaction in the Southern California area.
- Evaluate health consequences of conversion from fuel oil to coal in selected electric power generating plants.
- Develop short-term exposure data for sulfur oxides, nitrogen oxides, oxidants, and selected particulates.

Five-Year Plan

- Reassess exposure-response data for criteria and other pollutants collected from CHESS.
- Develop better exposure-response functions for estimating health risks of criteria pollutants, sulfate, and nitrate aerosols.
- Determine the significance of potentially dangerous trace substances, hazardous materials and unsuspected toxic substances to man.
- Identify the interactions in health effects of criteria and noncriteria pollutants.
- Describe interactive effects of multiple environment stress factors.
- Evaluate adverse health risks associated with indoor pollutants.

Transportation

A special identified area of research related to air pollution exposures is transportation. A biomedical data base needs to be developed to ascertain health risks associated with emission products from catalytic converter-treated auto exhaust such as sulfuric acid, sulfates, carbon disulfide, and hydrogen sulfide. Possible adverse effects from attrition products such as platinum, palladium, and aluminum oxide must also be evaluated. Specific focus shall be directed to the effects of sulfuric acid, sulfates, and related sulfur compounds generated as aerosols by oxidation catalysts. The potential health effects of emissions from fuel additives, alternative power sources and fuels and emissions associated with transportation of all types will be ascertained.

Adoption of catalytic converters to control regulated pollutants from mobile sources has become a matter of controversy. Toxicological and health effects data concerning sulfuric acid mist, sulfates and a number of other sulfur compounds are urgently needed by EPA to establish mobile source standard for sulfates. Information on possible biological effects of diesel emissions is also inadequate.

Air pollutants related to transportation receive special attention in ORD's health effects research.
CREDIT: EPA/DOCUMERICA - Gene Daniels

FY 1976 Plan

- Determine toxicological effects of sulfuric acid, sulfates and other sulfur compounds resulting from emissions of catalyst-equipped automobiles.
- Describe the comparative toxicology of emissions from engines equipped with catalysts vs. engines equipped with other control systems.
- Ascertain toxicity of respirable sulfur compounds and airborne respirable particulate mists.
- Provide emission characterization, measurement methods and emission factors for regulated and nonregulated pollutants from current, future and alternative engine-powered motor vehicles as related to fuel composition and fuel additives.

Five-Year Plan

- Ascertain public health consequences of all major components of the suspended particulate/sulfate mix.
- Refine the estimates of exposures to toxic materials from catalyst-equipped cars, and identify the most significant health hazards.
- Study the attrition products produced during the catalyst degradation stage.
- Initiate additional fuel additive studies after completion of ongoing catalyst exposure investigations.

Water Exposures

The water quality health effects research currently focuses on health implications of land application of wastewater and sewage sludges. Other areas of study include health effects of sewage treatment plants and fresh and marine recreational waters.

Health information for development and defense of criteria to insure protection of human health from disposal of wastewater and sludges is insufficient. Land treatment and disposal of these waters along with their disposal into waters has increased. Also, there has been a major national effort to increase the number and size of sewage treatment plants. Such installations may contribute to some human health hazards while alleviating others.

To determine the possible adverse health effects associated with land treatment and disposal of wastewater and sludges, research is planned to: determine the dispersion of pathogens, especially viruses in aerosols formed by spray irrigation of sludges and wastewaters; determine persistence and transport of pathogens in the soil of land applicator sites; determine in cooperation with FDA and USDA the persistence and movement of toxic substances in the soil, in ground water and in the food chain (metals, organics, inorganics, pesticides); and assess the health of populations living near wastewater treatment plants and in locales where land disposal of wastewater and sludges is practiced. This research obviously ties in closely with the ecological processes and effects research described later.

Health studies investigate the adverse effects of water pollutants.
CREDIT: EPA/DOCUMERICA - Erik Calonius

In addition to research associated with land application, study of water disposal of these wastes is needed. These include; determination of tolerable pathogen concentrations that may occur without jeopardizing health of humans in primary contact with marine water; development of valid microbiological criteria for shellfish growing waters (in cooperation with FDA); and quantitative correlation of human health effects to select indices of pollution in recreational fresh waters. Where possible, research is coordinated with the U.S. Army and U.S. Department of Agriculture who also have ongoing programs in this area.

This research will be expanded in FY 1977 to deal with viral problems related to land application of wastewater and sludges and to viruses in shellfish from marine waters. Plans for the FY 1977 program include increased health effects research related to aerosols produced by sewage treatment plants.

From these research results will come water quality criteria for recreational water and shellfish growing waters.

Another related research area, Water Supply Health Effects, supplements this research program. Funds are received from the Office of Air, Land, and Water Use (OALWU) to conduct health effects research on problems specifically associated with drinking water. Details of the water supply research program related to health effects are included in the description of the Water Supply Subprogram.

FY 1976 Plan

- Determine the potential of virus survival and movement at land reclamation sites utilizing sewage sludge.
- Correlate human health effects with selected indices of pollution in primary contact fresh recreational water.
- Report on health implications of aerosols from a municipal wastewater treatment plant.
- Determine the concentration of pathogens that can be permitted in marine recreational waters without jeopardizing human health.

Five-Year Plan

- Define health effects associated with exposure to land sites using treated wastewater effluents.
- Report on health implications of aerosols produced by use of treated sewage effluents for spray irrigation.
- Determine the potential of contaminants particularly trace metals present in sludge applied to land entering the food chain.
- Report on results of laboratory and field investigations to provide acceptable methods of sampling and analyzing sludge.
- Establish health effects criteria related to levels of sanitary, nutrient and thermal pollution for marine beaches.

Radiant Energy

The Public Health Service Act, as amended in 1970, gives the Administrator authority to conduct radiation research. Such research will provide scientific data for formulation of radiation standards.

Because of great concern about biological hazards from electromagnetic radiation, the Office of Telecommunications Policy (OTP), Executive Office of the President, initiated and is coordinating a multi-agency "Program for Control of Electromagnetic Pollution of the Environment: The Assessment of Biological Hazards of Nonionizing Electromagnetic Radiation." ORD's health effects research represents the greater part of EPA's total contribution to the OTP coordinated program. Health effects research is aimed at identifying biological effects that are caused by environmentally occurring electromagnetic radiation frequencies and power densities.

This research includes controlled animal experiments and basic mechanism studies with emphasis on long-term, low-level exposures. EPA's nonionizing radiation health effects research emphasizes the extent that the general population is exposed from sources such as UHF-TV broadcasts, microwave ovens, industrial heaters and radar. In addition to studies on nonionizing radiation, research is carried out on adverse health effects of exposure to tritium and Krypton-85.

The level of effort for nonionizing radiation research will remain about the same for the next five years. The research on ionizing radiation will be phased into the ERDA program in FY 1977 and thereafter.

FY 1976 Plan

- Report of microwave effects on immune response.
- Report on cytogenetic effects of microwave exposures.
- Report on teratogenic and mutagenic effects of microwave on mice and rats.
- Report on neurophysiologic and behavioral response of rats to microwaves.

Five-Year Plan

- Report on biological effects of chronic exposure to microwaves in rats.
- Determination of size of population-at-risk in nonoccupational exposure to high power electric transmission lines.

Pesticides

The pesticides health effects research evaluates acute and chronic exposure to pesticides, their residues and their metabolites. Indices of effects include mortality, growth rate, clinical signs of poisoning, hematologic factors and reproduction. Laboratory studies with experimental animals and community epidemiologic studies of human exposure to pesticides are conducted.

This research evaluates potential hazards of pesticides now registered by EPA and in common use. In addition, the human safety of "new generation" pest control agents such as insect viruses, pathogenic bacteria, chemosterilants, attractants and hormones is evaluated. The development and validation of new toxicological methods that can be used to register pesticides and development and application of analytical methods to detect these agents in environmental samples and human tissue, is a major part of the pesticides health effects research.

Research data and interpretation are given to the Office of Pesticides Programs (OPP) in a form useful for: assisting the reregistration process, formulating policies on the registration of new classes of pest control agents, improving the protocols required in registering pesticides, operating the human monitoring program and providing health and chemical information for enforcement of EPA actions relating to the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA). Reports will be issued at least yearly for base-program studies. Special projects involving technical assistance will be reported on completion. These activities assist OPP in its implementation of FIFRA at both federal and State levels.

Work by the National Center for Toxicological Research (NCTR) in cooperation with the Food and Drug Administration (FDA) is developing and validating new toxicological methods to evaluate exposure-effect relationships of new pesticides that are candidates for registration.

FY 1976 Plan

- Determine the toxicity range of cacodylic acid.
- Measure pesticide exposures and health hazards of persons working as pesticide applicators and for other field workers.
- Assess and quantify reproductive and prenatal effects of Hexachlorobenzene (HCB).
- Report on acute, subacute and chronic studies by various exposure routes of selected pesticides.
- Screen selected carbamates and organophosphate ester pesticides for neurotoxicity.

Five-Year Plan

- Report on special human health hazard problems associated with pesticides, including degradation and decontamination of surfaces where spills have occurred during transportation and storage and hazards related to disposal of small quantities of pesticides on farms.
- Assess and quantify the toxicity and teratogenic effects of substituted chlorophenol (SCP) compounds.

- Determine human exposure to biodegradeable pesticides and their metabolites. Some classes of pesticidal compounds included in these investigations are: (a) substituted carbamates, ureas and nitrogen-containing pesticides and herbicides, including nitro compounds and substituted triazines, (b) substituted phenols and amines, (c) organophosphorus-containing compounds and (d) halogenated compounds and derivates.

- Develop and standardize identification and monitoring techniques for Baccilovirus pesticides.

- Develop standardized procedures for identification, isolation and purification of insect pathogens and their products.

Toxic Substances

The purpose of the toxic substances work is to assess toxicity of inorganic and organic contaminants that reach people in a number of ways. The current research evaluates through use of animal testing, health effects of fibrous amphiboles, lead and the pesticide Baygon, cadmium, organic pollutants as influenced by trace metals and dioxin and dibenzofuran. This work supports the air and water health effects research as well and anticipates legislation on toxic substances control.

FY 1976 Plan

- Report on toxicity of fibrous amphiboles considered as carcinogens and co-factors.

- Report on the combined effects of certain trace metals and certain pesticides on the rate of metabolism of aminopyrene and antipyrene in rats.

Five-Year Plan

- Report on carcinogenicity and toxicity of fibrous amphiboles.

- Development of biochemical methods to screen organic and inorganic pollutants for specific biological activity potentially hazardous to human health.

Future Programs

A major reorientation of EPA's health research is its focus on chronic, debilitating diseases known to be related to environmental factors. This represents reorientation because past research design was intended to describe what diseases may be related to specific pollutants. Enough progress has been made to definitely relate chronic lung disease, cardiovascular disease and cancer to environmental pollution. EPA must now determine how these diseases are influenced by specific agents so that an effective control policy can be formulated.

Of course, many other environmentally-related diseases occur. The metabolic and neurobehavioral consequences of exposure to heavy metals, pesticides and other toxic substances do not fit into these broad disease categories. Research will continue in these areas. However, EPA's environmental health research will have a major influence on public health in the industrialized world if environmental factors shown to be materially involved in cardiopulmonary disease and cancer are identified and brought under control.

Health effects research keeps pace with the increased use of pesticides and substitute chemicals.
CREDIT: EPA/DOCUMERICA - Charles O'Rear

Ecological Processes and Effects

Subprogram Description

EPA has the responsibility to set adequate criteria, standards and guidelines to protect and enhance environmental quality. Ecological processes and effects research provides EPA with a body of knowledge and theoretical structure on which to base environmental criteria, standards and regulations.

Ecology is the scientific discipline and body of knowledge that should underlie management and use of the environment. Ecological research provides the data base essential to developing guidelines, water quality standards, secondary air quality standards, pesticide registration, ocean discharge criteria and effluent standards for toxic and hazardous materials, as well as directly contributing to many other agency activities.

Several fundamental features of ecological research should be emphasized in connection with EPA's regulatory responsibilities. Problem identification such as the disclosure that pollutant X causes human cancer implies regulatory consideration and also generates a plethora of environmental questions concerning pollutant X. Consequently, human health effects cannot be divorced from the ecological framework, as illustrated by the following questions.

- How does pollutant X behave in the environment and particularly how does it get to the human subject?
- Is pollutant X accumulated or concentrated by human food organisms? What is the effect of pollutant X on these and other nontarget organisms?
- Does pollutant X have significant effects on ecological systems that support human uses and what is a significant effect?
- What features of the fate, effects or transport of pollutant X allow for its control or will be useful for regulatory deliberations?
- What are secondary effects of abatement or regulatory strategies?

- How available is pollutant X in the natural environment?

The above questions illustrate the scope and purpose of ecological research: that of assessing, predicting and limiting the extent of environmental pollution problems and enhancing environmental quality where possible.

Ecological research activities respond to EPA's administration of environmental law and to changes in these laws. For example, P.L. 92-500 represents a major new direction in water quality regulation--a switch in emphasis from receiving-water standards to effluent standards. This change involves a greater overall emphasis on consideration of the ecological effects of process and control technologies and management methods.

To set an effluent standard that is strict enough to offer reasonable protection to aquatic environments and no stricter than necessary, requires prediction with reasonable accuracy of dispersion, transformation, accumulation and effects and economic damages of pollutants from the time they enter the environment to the time they are diluted to harmless levels (if that happens). Given the complexity of wastes as well as ecosystems, ecological research activities must be carefully examined and properly ordered to make best use of limited resources. These activities support the evaluation of effluent standards and discharge activities.

The Ecological Processes and Effects Subprogram is structured to recognize both broad ecosystem types and major research needs. Three ecosystem types--freshwater, marine and terrestrial--are sufficiently unique to justify separate treatment. Within each of these types, research is subdivided into "Ecological Criteria Development" and "Systems Characterization and Impact Assessment".

"Ecological Criteria Development" includes laboratory studies such as bioassays to establish tolerable pollutant levels. It also includes determination of single species effects or higher level effects such as those obtained from well-defined microcosm simulation. As a generalization, work performed under "Ecological Criteria Development" is performed in direct response to legislative mandates to define numerical standards for pollutant release. This work directly determines both the need for and extent of control or abatement measures. Since establishment of a pollutant level implies treatment or control measures and practices, this programmatic activity has serious and far reaching economic implications. This economic concern encourages work that is exact and precise.

"Systems Characterization and Impact Assessment" broadly covers projects that include: field studies; theoretical or mathematical simulations; development of methodologies to assess socio-economic impacts of pollutants, including assessment of resource utilization; and characterization of laboratory model ecosystems or microcosms for potential use in criteria development. In contrast to the first category, this category does not include routine use of well characterized model ecosystems for criteria development.

In addition to numerical criteria for air and water pollutants, technical criteria are developed to provide policy makers with guidelines on the environmental impact of municipal, industrial, agricultural and energy resource growth and development. These decision criteria allow environmental impact to be considered in early stages of a development planning cycle.

As such the ecological criteria portion of ORD's program provides a relatively quick response to EPA requests for technical and numerical criteria on the effects of specific pollutants on sensitive components of air, water and terrestrial systems. Systems Characterization and Impact assessment provides longer range research necessary to make numerical criteria more meaningful for whole systems. Research outputs from both categories are necessary to meet objectives of the Ecological Processes and Effects Subprogram.

In the future, however, more effort will be placed on systems studies designed to yield information on pollutant effects on entire systems. In the past, ORD criteria for effects were based on studies of selected species. Current scientific opinion and recent judicial proceedings indicate a need to evaluate the impact of pollutants on entire systems as well as on individual species. Unfortunately, satisfactory methods for such systems evaluation are still inadequate.

The following sections describe major aspects of the FY 1976 ecological effects program together with a five-year plan describing anticipated major outputs and research approaches.

Freshwater Ecological Criteria Development

The freshwater ecological criteria development research focuses on determining effects of pollutants or other stresses on aquatic organisms, including determination of environmental requirements and limits. This work will also determine general principals governing the transformation, accumulation and ultimate fate of pollutants in freshwater ecosystems and by means of laboratory-scale model ecosystems and field studies, the ecosystem level effects of pollutants and other stresses.

The completed information from these research activities will be used by federal and State regulatory agencies to establish standards for pollutants such as chlorine and chlorine substitute pesticides, other organic compounds, asbestos and asbestos like fibers and heavy metals. In addition, research results will give users up-to-date methods to determine the impact of pollutants on freshwater organisms.

Problems associated with lake eutrophication are addressed by research on ecological processes and effects. CREDIT: EPA/DOCUMERICA - Belinda Rain

Continued research is needed to develop and improve criteria as new pollutant problems and our awareness of them changes and as new and improved analytical techniques, pollution control technology and understanding of ecosystems develops. An increased emphasis over the next five years will be on supplementing pollutant criteria based on specific representative organisms with data obtained from currently-being-developed standardized laboratory model ecosystems and microcosms.

FY 1976 Plan

- Determine the toxicity of disinfected wastewater effluents and the bioaccumulation of organic compounds by fish exposued to these and other wastes.
- Determine the distribution, effects on aquatic life (singly and in combination with other pollutants) and intermedia transport of asbestiform fibers.
- Evaluate acute, chronic, synergistic, antagonistic and additive effects of selected organic and inorganic pollutants and pollutant combinations.
- Determine behavioral responses of aquatic organisms to selected pollutants and other stresses.
- Characterize the degradation of organic pollutants in cold climate ecosystems.
- Determine effects of dissolved gas supersaturation on selected species of salmonid and nonsalmonid fishes.

Five-Year Plan

- Develop criteria for the control of pollutant effects in Arctic and Subarctic freshwater ecosystems.
- Increase emphasis on determining response of aquatic life to combinations of toxicants and other stresses.
- Determine movement, deposition, transformation, and effects of pollutants in large, semicontrolled experimental stream channels open to environmental variations.

- Determine fate and effects of pollutants in laboratory-scale model ecosystems.

- Use laboratory scale model ecosystems for rapid screening of pollutants to isolate potentially problem materials.

- Determine extent and significance of the sorption of pesticides, metals and other toxicants onto particulate matter.

- Improve knowledge of dissolved oxygen requirements of important invertebrates and warmwater fishes.

- Determine the role of aquatic organisms in transforming heavy metals as the metals enter the environment.

Freshwater Systems Characterization and Impact Assessment

The freshwater systems characterization and impact assessment research focuses on: determining the source, transport, transformation effects and ultimate fate of pollutants in specific freshwater ecosystems, with on special emphasis the Great Lakes; understanding the eutrophication process in freshwater ecosystems, developing methods for evaluating the trophic status of natural waters and developing methods to reverse or redirect undesireable effects of cultural eutrophication; determining the effects of man-induced stresses on Arctic ecosystems; and characterizing laboratory model ecosystems to be used for ecological criteria development.

Field studies carried out in this area are essential in validating data obtained from laboratory studies, in assessing impacts of environment stresses and of stress decreases following control programs and in identifying new problems before they become serious. EPA's research commitment to the U.S.--Canada Great Lakes Water Quality Agreement of 1972 is fulfilled through this research activity.

An important new area of emphasis is development, characterization and standardization of laboratory model ecosystems or microcosms. Such models can be used to study freshwater and multimedia ecological processes and effects under controlled conditions and to quickly screen pollutants most ecologically hazardous. Among the important outputs of this area over the next five years will be: an integrated set of predictive mathematical models of key chemical, physical and biological processes in the Great Lakes; a thorough analysis of National Eutrophication Survey data on a nationwide basis to determine relationships between land use, nutrient source, and lake trophic status; and assessment of full-scale lake restoration activities carried out under the Clean Lakes Program.

FY 1976 Plan

- Continue the National Eutrophication Survey: a systematic inventory of trophic conditions of selected lakes in the continental U.S.
- Develop and apply eutrophication and algal production models of Lakes Ontario, Erie, and Huron to predict consequences of nutrient control programs.
- Continue assessment and identification of pollution problems in the Great Lakes such as accumulation of polychlorinated biphenyls (PCBs) and other organics in Great Lakes fish.
- Evaluate advanced waste treatment, nutrient diversion, nutrient inactivation and biological manipulation as lake restoration techniques.
- Develop and refine predictive models of the eutrophication process.
- Characterize laboratory model ecosystems as potential research and screening tools for evaluating and predicting ecosystem effects of pollutants.

Five-Year Plan

- Develop improved understanding of functioning and variability of natural ecosystems by support of relevant baseline and theoretical research.
- Evaluate the rate and extent of recovery of ecosystems following removal of a stress to better predict the effectiveness of particular pollution control options.

- Continue research on Great Lakes ecosystems oriented towards identifying and assessing pollution problems.

- Determine the effectiveness of nutrient control programs in the Great Lakes and other freshwater ecosystems.

- Continue to characterize additional laboratory-scale model ecosystems for use as toxic substances screening and effects research tools.

- Evaluate the ecological effects and effectiveness of lake restoration projects carried out under the Clean Lakes Program and other activities, including Shagawa Lake.

- Complete the National Eutrophication Survey (NES) and perform detailed analyses of the NES data base to determine relationships among land-use, point and nonpoint source inputs and lake trophic status.

- Develop and characterize new and improved methods of lake restoration, including ecosystem level approaches such as biological alteration.

Marine and Estuarine Ecological Criteria Development

A number of successful efforts, including an assessment of progress on estuaries and research influencing EPA's direction in administering P.L. 92-500 have led to changes in ORD research planning in the area of Marine and Estuarine. ORD needs to continue development of single species and single pollutant bioassay methods research and concurrent research in chemical analyses to support the pollutant bioassays as inputs into regional permit program needs. These efforts will continue, tapering off to conclusion after 1980.

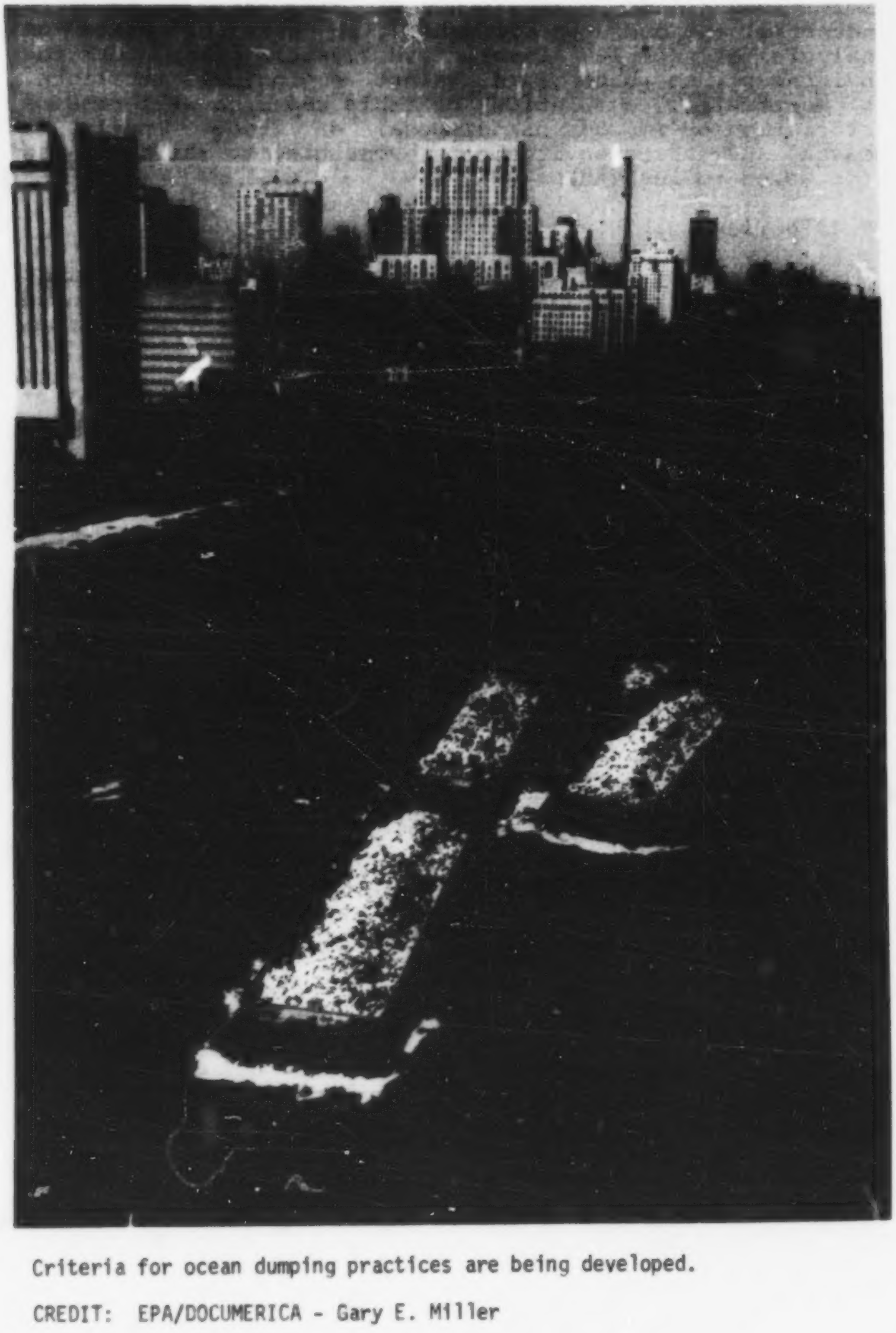
Although much of the research being carried out in FY 1976 will be continued in the following years, ORD foresees changes in the type of research output. There will be less emphasis on the single parameter water quality criteria (summary reports on toxicities of specific metals, pesticides, disinfectants and other criteria to be published periodically through 1980) and more emphasis on developing test systems for evaluating the near field impact of a chemically complex effluent. ORD believes that such information will be of better use in the development of legally defensible water quality criteria, effluent limitations and guidelines for disposal of numerous industrial and domestic effluents. It will be based on analysis of complex interactive systems that form the environment, so as to guard against ecological imbalance. In particular, completion of this research will produce information on impact of disposal of dredge spoils on coastal and marine environments, something to which EPA has been asked to respond.

FY 1976 Plan

- Determine fate and effects of organic and inorganic pollutants, singly, in combination and in mixed wastes, as discharged into estuarine and coastal areas.
- Determine the ecological impact of various levels of environmental parameters such as, but not limited to, temperature, dissolved oxygen and salinity.
- Determine criteria for waste outfalls in the marine environment.
- Assess the ecological significance of indices of community structure and population dynamics and the use of such indices as criteria for measuring the "health" of marine ecosystems.
- Determine the effects of antifouling biocides and disinfectants on marine species and ecosystems.

Five-Year Plan

- Develop criteria for dredge material disposal.
- Develop criteria for long-term, low-level thermal pollution in both polluted and unpolluted environments.
- Report on fate of metals in an estuarine environment.
- Development of multiple species and multiple pollutant bioassay procedures.
- Development of criteria for third generation pesticides.



Criteria for ocean dumping practices are being developed.

CREDIT: EPA/DOCUMERICA - Gary E. Miller

- Development of a rapid screening technique for testing substances for mutagenicity and toxicity.

- Revision of bioassay procedures for the ocean dumping permit program.

Marine and Estuarine Systems Characterization and Impact Assessment

The FWPCA (P.L. 92-500) contains a clear mandate from Congress for EPA to employ ecology as a predictive science. This requires research on means to describe quantitatively what a "balanced indigenous population" is and to define quantitatively what amount of stress will drive ecological communities in question out of "balance".

The research effort presently includes laboratory modeling, simulation of specific estuarine ecosystems, concurrent field measurements and verification of model results and impact assessment. Much of the research carried out in FY 1976 will be continued into the following years. The first five years of effort should produce a predictive physical model of ecosystem dynamics for one or two estuaries, verified by computer modeling of what ORD believes to be ecologically active factors and field validation in the estuaries modeled.

ORD expects to apply knowledge gained in this five-year effort to promulgate and update guidelines for ocean outfall siting, ocean dumping, impact assessment of thermal and chemical discharges and a variety of specific regional permit problems. Following successful technology transfer to the private sector, the research program may be reduced to a level suitable to maintain Agency expertise and act on occasional unique pollution episodes and helping communities affected. It will then become a technical assistance effort.

FY 1976 Plan

- Determine the dynamics of relatively unpolluted natural estuarine ecosystems.

- Develop conceptual, computer and mathematical models of storage and flow of natural products and pollutants in polluted and relatively unpolluted estuaries and coastal environments.

- Develop simulated ecosystems using natural and artifical estuarine communities to predict the fate and effects of pollutants.
- Produce procedures and guidelines for assessing, predicting and demonstrating environmental impact from ocean disposal practices.
- Determine the fate and ecological effects of petroleum and petroleum derived hydrocarbons and produce guidelines for damage assessment and methods for predicting impacts from new sources.
- Assess the effects of existing stresses from various industrial and municipal wastes on Subarctic marine environments.

Five-Year Plan

- Determine the fate and effects of viruses introduced into the marine and estuarine ecosystem.
- Determine the fate and effects of the ocean disposal of stack scrubber waste material.
- Report on the impact and guidelines for predicting the impact of dredge spoils and sewage sludge.
- Report on the distribution of carcinogenic compounds derived from petroleum hydrocarbons.
- Assessment of biological effects of ocean disposal of sewage waste in southern California, New York Bight and Arctic coastal waters.
- Assessment of ecological impact from dredging and dredge spoil disposal.
- Determine the fate and effects of inert ingredients found in pesticides.

Terrestrial Ecological Criteria Development

The Terrestrial Ecological Criteria Development Area focuses on supporting air pollution control strategies that will protect public welfare by determining the ecological and physiological effects of air pollutants and other pollutants on terrestrial flora and fauna when they are coupled with various environmental stresses. The work in progress will determine general principles governing transformation, accumulation and eventual fate of air, pesticide, and other pollutants in terrestrial ecosystems. Such determinations will be made by means of field, greenhouse and laboratory studies and by use of scale model microcosm ecosystems.

In particular, completion of these studies will strengthen and document criteria for sulfur oxides, nitrogen oxides, photochemical oxidants and noncriteria pollutants. These data have been requested by EPA's Office of Air Quality Planning and Standards. Furthermore, the completed research will allow EPA to achieve the scheduled updates on criteria pollutants prescribed in the Clean Air Act.

Information on selected noncriteria (e.g., heavy metals) pollutants will be similarly updated. And the completed data will provide the basis for future air pollution control strategies. Finally, completion of the research will provide the basis for evaluation of the significance of naturally occurring air pollutants such as hydrocarbons and ethylene.

FY 1976 Plan

- Develop and refine scientific basis for secondary air quality standards and for control strategies as cited in the Clean Air Act,
- Develop a scientific basis for control and regulation of selected pesticides and other toxic or hazardous materials.
- Determine the ecological and physiological effects of pesticides and other toxic substances on terrestrial ecosystems by use of simulated models and ecosystems.
- Measure acute and chronic terrestrial ecosystem responses to various pollutants, singly and in combinations.
- Determine usefulness of ecological indices as pollutant stress indicators and enforcement tools.

Five-Year Plan

- Develop terrestrial ecological models describing pollutant pathways, transformation, and fate.
- Continue development of scientific basis for secondary air quality standards.
- Determine movement, disposition, transformation and effects of pollutants in microcosm terrestrial ecosystems.
- Develop pollutant fate and nutritional element recycling effects of acid rain on plant communities and soil systems.
- Determine and develop criteria guidelines for registering third generation pesticides.
- Determine pollutant transport pathways, transformation and ecological effects of pesticides in urban use.

Terrestrial Ecosystems Characterization and Impact Assessment

The Terrestrial Ecosystems Characterization and Pollution Impact Assessment work focuses on scientific characterization of disrupted and/or natural terrestrial ecosystems or their parts that have been, are, or are about to be impacted by air- or rain-borne pollutants. Such pollutants occur singly or in combination in varying concentrations and for varying exposure periods. The data can be mathematically modeled or subject to interpretation without being modeled. Findings will be used to predict either ecological or economic damage to terrestrial ecosystems based on projected pollutant concentrations, exposure duration and ambient environmental conditions as they act on typical biota of a given region, location or site.

Future studies will allow development of prototype control strategies related to entire ecosystems. Also, effects of pollutants on stability of vital biological processes in viable forest, grassland, and agricultural ecosystems, will be meaningfully fitted into ecosystem characterizations. The biological processes will include photosynthesis, nitrogen fixation and nutrient recycling. Completed studies will also reveal actual rates of ecosystem degradation of a coniferious forest ecosystem under oxidant stress.

FY 1976 Plan

- Determine and characterize impact of air pollutants on flora and fauna of a grassland plains savannah ecosystem.
- Determine and characterize impact of air pollutants on a coniferous western forest ecosystem.
- Determine and characterize pollutant impacts on ecosystem components of disturbed, e.g., agricultural, ecosystems.
- Develop predictive terrestrial ecosystems models that may include socio-economic and demographic analysis and resource utilization evaluations.

Five-Year Plan

- Determine and characterize air pollutant effects on deciduous, grassland, and coniferous ecosystems.
- Develop and verify ecosystem predictive and transport models of pollutant impact studies for major ecosystems.
- Develop population dynamic models for microbiotic communities under pollutant stress.

Transport and Fate of Pollutants

Subprogram Description

Development of effective pollution control strategies requires linking pollutant impacts to sources. The Transport and Fate Subprogram is primarily responsible for development of empirical and analytical techniques that relate air and water pollution source emissions and discharges to ambient exposures. This requires research and model development in: (a) atmospheric soil and aquatic ecosystem processes and effects for determination of pollutant sources, interactions, transport, transformation and sinks; (b) effects of air pollutants on visibility, rainfall, and climate; and (c) impacts of water pollutants of water quality.

Following is a description of the transport and fate research as divided into air and water and an identification of major outputs over the next five years.

Air

The Clean Air Act of 1970 introduced an era of stringent standards and deadlines for achieving air quality goals. However, some ramifications of achieving clean air have only recently, come sharply into focus. The direct costs of achieving clean air by control of stationary and mobile sources are better known and the indirect impacts on land use, energy supplies and other goals have become more apparent. Sophisticated "hardware" controls alone are no longer considered enough or the sole solution to air quality improvement.

In this period, knowledge of many atmospheric processes governing transport and transformation of pollutants in the atmosphere has progressed. However, available new information has revealed significant information gaps that may hinder progress in effectively managing atmospheric quality. The gaps most likely to receive attention in the near-term include the transport and alteration of sulfates under both regional and global conditions and on the well-established problem of oxidants in local and regional areas. Emerging problems, such as freon and other hazardous substances, are also likely to receive more attention.

Processes that alter air pollutants in the atmosphere are dynamic and must be understood in order to develop effective abatement strategies.

CREDIT: EPA/DOCUMERICA - Gene Daniels

During the past three years, the ORD has conducted a major Regional Air Pollution Study (RAPS) in St. Louis to develop and validate regional-scale models for criteria air pollutants. Planned accomplishments include: (a) completion of emission inventory methodologies, (b) development of models for nonreacting pollutants, (c) development of models indicating transformation, and (d) improved understanding of pollutant/precursor removal processes.

Field investigations will soon be conducted to determine the physical and chemical description of atmospheric gaseous and particulate matter. The major atmospheric effects, including acid rainfall, visibility reduction, climatology and radiation balance, will be studied. Identification and quantification of regulated and important nonregulated pollutants will be determined in both urban and nonurban atmospheres.

Ambient pollutant levels will be quantitatively described in terms of contributing emission sources. Subjects included are: (a) oxidant transport, (b) physical and chemical characterization of atmospheric aerosols and gases, (c) source identification of ambient pollutants (e.g., natural vs. powerplant vs. area sources) and (d) freon and halocarbon abundance in the troposphere.

Air quality simulation models will also be developed, evaluated and validated to provide qualitative and quantitative methods for predicting and describing air quality from a variety of emissions sources. Included here are: (a) model development for important pollutant categories and configurations (e.g., highway, point sources, area sources, etc.); (b) model evaluation; (c) model testing protocols and (d) guidelines for physical model use.

FY 1976 Plan

- Report on the evaluation of the second generation photochemical model.
- Adapatation of two urban air quality models to St. Louis (Regional Air Pollution Study).
- Report summarizing current knowledge on hydrocarbon-photochemical reactivity.

- Report on plume rise climatology for the U.S. for evaluation of powerplant sites.
- Report on photo-oxidation products from NO and aromatic hydrocarbon pollutants.
- Summary report on acid rainfall distribution over the U.S.
- Report on the effects of air pollutants in the urban-rural radiation balance.
- Interim report on the relative contributions of area sources and large point sources of ambient sulfate levels.
- Report on abundance of fluorocarbons and other important halocarbons in the troposphere.
- Report results of 1975 summer experient, photochemical oxidant transport in lower New England.
- Report on sampling and analysis techniques for particulate matter emissions of diesel-powered highway vehicles.
- Urban-Rural Air Pollution Characterization and Source Identification.

Five-Year Plan

- Development of sampling and analysis techniques for identification and measurement of: condensible emissions from mobile sources; condensible emissions from stationary sources; organics from chemical and petrochemical plants; regulated pollutant emissions from mobile sources.
- Urban-rural air pollution characterization and source identification:
    - Report on nonregulated pollutants in the New York-New Jersey area;
    - Report on natural sources of oxidant precursors;

  - Reports on nonregulated pollutants in Birmingham;

  - Agricultural area in Region VII; and Los Angeles.

- Identification and characterization of emissions from stationary sources including toxic metals and organic emissions from petrochemical sources.

- Regional Air Pollution Study:

  - Development urban sulfate models to be used against RAPS data base;

  - Evaluation of sulfate and nonsulfate models.

- Air quality simulation modeling.

- Removal mechanisms for atmospheric nitrates.

- Progress report on the role of precipitation washout and rainout on sulfates and nitrates relative to long-range transport.

- Report on recommendations for control of fine particulates.

- Atmospheric effects:

  - Impact of air pollution on selected bodies of water.

  - Trends in visibility.

  - Assessment of air pollution modification of regional weather and climate.

- Final report on the relative contributions of area sources and large point sources to ambient sulfate levels.

- Final report on oxidant transport studies.

Water

The establishment of water quality criteria and standards, the development of load allocations and subsequent issuance of permits, the development of basin management strategies and pursuit of enforcement actions depend on a knowledge of how contaminants are transported and transformed in the aquatic environment. This scientific information is necessary in order to: (a) establish environmentally judicious water quality standards; (b) assume scientifically defensible positions in litigations; (c) predict stream assimilation capacities and pollution impact in order to establish optimum waste load allocations and basin management on a compound-by-compound basis; (d) optimize design and construction costs; and (e) attain optimum environmental protection with maximum energy conservation.

The near-term primary objective of this research is to develop information and tools necessary to support Agency requirements arising from P.L. 92-500 and other legislation. Since passage of P.L. 92-500, EPA has initiated many activities including: development of water quality criteria that will be issued in the near future as a basis for revising State water quality standards; development of first-generation load allocations and permits; designation of area-wide basin management authorities; and initiation of several enforcement actions.

ORD expects that revision of water quality criteria will be required in the 1978-79 time period to meet 1983 water quality goals; that more sophisticated load allocations, incorporating heavy metals, pesticides and other constituents, will be necessary for second generation permits; and that comprehensive basin plans will require more advanced technical tools and scientific information to provide equitable controls among point and nonpoint sources and to identify mechanisms for their implementation.

Research objectives involve identifying and assessing present and future water quality problems and providing OWHM with research data on fate, transport, and aquatic ecosystem impact of specific pollutants. This information is needed to support water quality criteria development and pesticide registration. Form and impact of pollutants in time and space must be provided in the regions and States for basin planning and waste load allocations in water quality limited systems.

Comprehensive basin water quality models with point and nonpoint source inputs, socio-economic implications and energy conservation inputs will be provided in research applications reports, scientific papers and problem reports, including model user manuals and card decks and hands-on demonstration, technical assistance, and feedback. Research application and problem-oriented reports include an analysis of the environmental applicability and limitation of available information.

FY 1976 Plan

- Development of an evaluative model for predicting the distribution and half-life of pesticides among the various substrates of fresh surface water ecosystems and calibrating it for malathion.
- Development of an evaluative model for predicting the distribution and half-life of mercury among the various substrates of fresh surface water ecosystems.
- Development of procedures for estimating water quality (relative to sediment and nutrients) that would exist in a given watershed under various hypothetical land use practices (including return to a "natural" state).
- Development of additional source loading functions to predict pollutant loads to streams from nonpoint sources.
- Coupling of nonpoint source loading models to basin water quality models for use in assessing water quality impacts (relative to BOD, sediment, and nutrients) of both nonpoint and point sources.

Five-Year Plan

- Provide EPA's Office of Toxic Substances (OTS) and ORD/OHEE with suitable multimedia microcosm techniques (and user instructions) for use as tools in predicting environmental distribution of various classes of pollutants that would result if released into the environment.
- Complete laboratory evaluation of heavy metals (in water) submodel; verify (in laboratory and experimental field systems) and calibrate for

mercury. Provide user manual to OTS, and EPA's Office of Pesticide Programs (OPP) and Office of Water Planning and Standards (OWPS).

- Expand pesticide (in water) submodel to handle persistent pesticides and highly volatile pesticides; verify (in laboratory and experimental field systems) and calibrate with Atrazine (representative of persistent pesticides) and Trifluralan (representative of highly volatile pesticides). Provide user manuals to OPP, OTS, and OWPS.
- Provide manual to OWPS, regions and "208" planning agencies on methodology for estimating "nautral" (or background) water quality (with respect to sediment and nutrients) that would exist in a given watershed or basin under various hypothetical land use practices (including non-use) given soil, geomorphic, climate and groundwater characterisitcs.
- Develop source loading functions to predict pollutant loads to streams for those nonpoint sources identified in the project, "National Assessment of Nonpoint Sources", as significant and where functions are either not available or unreliable. Provide user manual on use of these loading functions to OWPS, regions and "208" planning agencies.
- Assess currently available nonpoint source (NPS) loading models (for estimating NPS pollution contributions of BOD, sediments and nutrients from various sources) developed in other programs and improve and develop additional models as required to couple with basin water quality models for use by the regions and "208" planning agencies in assessing water quality impacts (relative to BOD, sediments, and nutrients) of both nonpoint and point sources.
- Provide improved or additional NPS loading models coupled to basin water quality models.

Socio-Economic Studies

The socio-economic research uses interdisciplinary techniques and skills to define environmental problems and approaches to solutions of problems that are not in the immediate short-term purview of EPA's program offices. This research gives EPA an ability to cope with current and future environmental problems and issues that may be critical in the long-term, but are not problems now.

The groups doing this work will be assembled in FY 1976 and be at full or nearly full strength by the beginning of FY 1977. Since this activity is now being structured the five-year plan cannot be described with any certainty now. However, following areas are likely candidates from which the five-year program will be assembled:

- **Economic Epidemiology.** This area considers socio-economic and demographic factors associated with environmental health. These data will serve to complement the medical epidemiology and provide data for benefits studies.

- **Benefit Studies.** This area develops environmental benefit methodologies and uses them to determine the gains of environmental programs. Emphasis will probably be on pesticides, toxic substances and drinking water.

- **Future Pollutant Problems and Pollutant Assessment.** This area is an interdisciplinary one that attempts to "get ahead of the problem" and identify future pollution problems early enough to devise control strategies that protect at much lower cost than required when the problem is serious.

- **Ad Hoc Studies.** These are studies of short duration (three to six months) on specific EPA issues as they arise. The studies are particularly useful for two reasons: First, they allow EPA to use resources not available elsewhere for short-term issues; and second, it gives researchers direct exposure to EPA's problems. These activities would help assure the relevancy of the socio-economic research to real Agency problems.

- **Conservation Issues.** This area will define the problem of evaluating natural environments and outline various approaches for coping with conflicts of interests between conservation of nature's unique feasures and economic development.

- **Waste Reduction.** This area will explore: (1) resource depletion problems. and environmental and economic benefits of reducing the amount of wastes; (2) methods of encouraging materials conservation and consequences of alternative management methods.

- **Methods and Model Development.** Where appropriate methods and models appropriate for use in environmental analysis will be developed, verfied and prepared for socio-economic assessments.

INDUSTRIAL PROCESSES PROGRAM

Overview

This program includes two research subprograms: Minerals, Processing and Manufacturing Industries; and Renewable Resources Industry. The split is made on the character of sources being investigated--point and nonpoint sources, respectively.

The Minerals, Processing and Manufacturing Industries Subprogram considers point sources of water, air and residue pollution produced by industry. Research, development and demonstration in this subprogram focuses on mining, manufacturing, service and trade industries with activities that range in scope from extraction to production of raw materials and processing of materials into intermediate and consumer products.

Research on water industrial processes supports the "Best Available Technology" (BAT) requirements of the Federal Water Pollution Control Act (FWPCA) through development and demonstration of new or improved cost-effective technology with industry-wide applicability, short-term achievability and long-term viability. This research provides primary data for establishing economically and technically feasible effluent guidelines and treatment parameters for industrial liquid-waste discharge permits. The research also considers technology for preventing and controlling accidental spills of hazardous materials.

Industrial processes water research will focus on development and demonstration of technologies for closed-cycle systems except when: open-cycle technology research is required for standards verification; or closed-cycle is not feasible. Roughly 32 of the total 593 regulatory categories will be affected by the more viable technologies demonstrated. The area-wide combined water research will continue to show the economic and technical viability of combined point source wastewater management with special emphasis on developing technical criteria for pending pretreatment standards.

Hazardous incident research will continue on control and minimization of spill damage and to provide data for the new EPA spill regulations for hazardous materials.

Over the longer-term industrial processes water research will continue to respond to technology requirements of the FWPCA. Increased attention will be directed to hazardous waste disposal and demonstrations of technology for specific critical industrial sources. The integrated regional hazardous waste disposal facility will be continued.

Research on air industrial processes supports the technology requirements of the Clean Air Act (CAA) through development and demonstration of new or improved cost-effective technology with industry-wide applicability, short-term achievability and long-term viability. These requirements support implementation of ambient air quality standards and the development of New Source Performance Standards (NSPS).

Since a significant amount of air pollution comes from energy production and use, it is reasonable to expect considerable overlap between this and the Energy/Environment Program described later in this report. The Minerals, Processing and Manufacturing Subprogram and the energy-related research have been carefully structured to complement each other for that reason.

Near-term air pollution control technology research focuses on assessing the magnitude of problems and the state-of-the-art for control of noncriteria and hazardous pollutants (i.e., hydrocarbons and metallic particulates) while completing several development and demonstration projects on criteria pollutant control systems. Work has also begun on transferring technology for particulate control to industry (see description of Technology Transfer Activities). The results of the assessment studies will provide identification, characterization and prioritization of industrial sources of hazardous pollutants. This information will permit development of national strategies to control industrial air pollution.

Over the longer-term, activities will continue to characterize and assess air pollution problems from industrial sources and identify available technology for pollution control and its economic implications. This information will continue to be used to formulate specific technology requirements and strategies to control air pollution from industrial sources. Demonstrations of control technology for high priority sources will also continue.

The Renewable Resource Industry Subprogram includes: (a) development of total management systems, including predictive methodology, to control air, water and land pollution resulting from production and harvesting of food and fiber and their related residual wastes; and (b) the assessment of probable trends in production of renewable resources and their resulting environmental impact, including effects of crop production on irrigated and nonirrigated lands, silviculture practices and animal production.

This research supports development of guidelines to identify and evaluate the nature and extent of agricultural and silvicultural sources of pollution and processes, procedures and methods to manage pollution from these sources (as required by FWPCA). Also vital is giving necessary support in assessment and management of pollutants resulting from production of renewable resources as required by State and local agencies in carrying out area-wide waste management responsibilities under Section 208, P.L. 92-500.

Studies related to animal production and land application of wastes from confined animals, management of animal wastes from operations not covered by the National Pollution Discharge Elemination Systems (NPDES) requirements and waste disposal where land application is not feasible, are being performed. Irrigated crop production studies, including irrigation system management and predictive methods, to manage and reduce mass loading of pollutants in irrigation return flow systems are also being conducted. Research on nonirrigated crop production relates to chemical and sediment management systems, predictive modeling and long-term trends.

In the longer-term, problems to be addressed in animal production research are: potential runoff and resulting pollution from land application of animal wastes; development and assessment of cost-effective techniques for management of land runoff and development of cost-effective systems to manage pollution from non-NPDES operations, including waste holding structures.

Siviculture activities are directed to development of forestry management systems and techniques that predict environmental consequences of these systems. An assessment will also be made of short- and long-term trends in forestry as they impact environmental quality.

Also, over the longer-term, activity will be increased to expand upon the initiation of assessment of short- and long-term trends in agricultural production as they impact on environmental quality. This work will focus on specific analysis of environmental impacts from highest priority agricultural systems such as large-scale farming, conversion of marginal lands to cropland, chemical and energy intensive practices and the likely increase in irrigation.

Minerals, Processing, and Manufacturing Industries

Subprogram Description

Industrial pollution is the source of about half the biological oxygen demand (BOD) of the Nation's lakes, rivers and streams. Industry also produces most of the water pollution load of refractory, hazardous and toxic materials, including heavy metals, organics and dissolved solids. Similarly, even with control levels required under New Source Performance Standards (NSPS), half the emissions of particulates and a significant fraction of the emissions of sulfur oxides (SOx) into the atmosphere come from industrial sources. And most hazardous atmospheric pollutants come from industrial sources.

While solid wastes from industrial sources are a relatively small fraction (about one-fifth) of the total wastes generated from all sources, industrial sources have a significant impact because of their hazardous and toxic nature due in part to production of large amounts of sludges with heavy metals.

To address these industrial environmental pollution problems, a research, development and demonstration (R,D&D) program to identify, prevent, control and manage pollution from industrial activities has been established. The Minerals, Processing, and Manufacturing Industries Subprogram includes sources of water, air and residue pollution from industrial activities--mining, manufacturing, service and trade industries. The activities involved range from extraction to production of raw materials and processing of materials into intermediate and consumer products. This research covers all or part of thirty major groupings identified in the Standard Industrial Classification.

Industrial pollution problems cannot be effectively controlled by attacking only a single medium (i.e., air, water or land). A more effective approach is to deal with pollution as problems whose solutions may impact on all media. A systems approach that takes air, water and land into account to treat pollution problems avoids transferring pollution impacts from one medium to another, e.g., treatment of liquid effluents in a way that produces no secondary air pollution or land disposal problems.

Pollution runoff from mining operations continue to be a problem in many areas.

CREDIT: EPA/DOCUMERICA - Bill Gillette

To emphasize a coordinated, multimedia approach to industrial pollution problems, the research activities are organized along industrial lines. Responsibility for total environmental protection is assigned to each industrial component. Four research categories--Materials Production, Materials Processing, Combined Sources and Hazardous Materials Incidents--comprise the Minerals, Processing, and Manufacturing Subprogram. Since industry generally considers its environmental problems to be multimedia problems, it is essential that each research category include all environmental problems associated with that category.

Materials Production includes problems of industries concerned with exploration for and exploitation and production of raw materials such as steel, aluminum and limestone. Not included in this category is extraction of nonrenewable resources used primarily as a source of energy, such as coal, or renewable resources, such as agricultural products.

Materials Processing covers many industrial activities that mechanically or chemically change a material from one form to another. For example, metal working and electroplating, as well as production of inorganic and organic chemicals, are included in this category.

Combined Sources covers the development of technology to treat industrial wastes from several plants within a region with a single facility or in combination with municipal waste management. Hazardous Materials Incidents develops methods to treat spills of hazardous materials as required in the FWPCA.

A goal of this research is to serve as a catalyst to promote cooperation and coordination between federal agencies, States and technology users to achieve levels of pollutant control mandated by EPA's legislative authorities. Research objectives are planned to meet the timing for reduction or elimination of pollutant discharge required by the FWPCA and the CAA. Pollution abatement goals will be helped by this program through R,D&D technology on a wide spectrum of industrial activities, culminating in demonstration or promotion of cost-effective pollution control technologies.

Industrial organizations will continue to be responsible for most development and demonstration efforts required to meet pollution abatement goals. Solutions to industrial pollution problems may include commercially-available treatment technology or adaptations of control technology in use on other processes. Pollution problems may also be prevented or controlled by modifications in process design or operation--solutions that may be specific to a single plant and wholly under purview of the plant operator. In certain critical cases, however, federally financed, independent R,D&D may need to be conducted to ensure that national pollution abatement goals will be met.

Progress is being made toward reduction or elimination of industrial pollutant discharges. Results are incomplete, however, because of a lack of feasible cost-effective technology to meet standards. Some industries are characterized by small organizations with modest or no R,D&D components. These industries may not be able to adapt or develop pollution control methods without external sources of resources and expertise. Other industries have challenged the technical and economic bases of regulations--both those currently applicable and those scheduled to come into effect in the future.

Finally, the obvious need for new standards to control or prevent discharge of toxic and hazardous pollutants from industrial sources will produce new requirements. Protection measures required under such standards may be significantly different from those commonly used in industrial pollution abatement, and may require intensive cooperative efforts to meet standards.

The development and application of both existing and future abatement technology is a cornerstone of FWPCA. This legislation makes it necessary to develop advanced treatment technology to eliminate the discharge of industrial pollutants in a manner that neither creates other pollution problems nor is unacceptably disruptive to the economy. Associated with that constraint is the necessity to prove economic viability and reasonableness of interim pollutant control levels by 1985.

Under the FWPCA, there are approximately 593 regulatory industrial categories, each with four levels of control to be achieved within a 10-year span. Effluent Guidelines have been established by EPA in 33 industries and more guidelines will be promulgated in 1975 and 1976. Progress toward achieving levels of control mandated by the Act depend both on resolving legal differences between EPA and industries that must comply with the Act and provision of the substantive basis for technical and economic feasibility.

Under the CAA, several regulatory paths are available for devising strategies to ensure that mandates of the Act are met. Industrial technology research supports each of these regulatory approaches. Ambient Air Quality Standards (AAQS) have been established for six pollutants, known as criteria pollutants. The States have submitted implementation plans that provide for attainment of the AAQS. Many areas will not attain the AAQS because they lack available control technology, control is too costly, or fuel supplies are limited.

The standard can be attained in some cases. But the likelihood is that existing technology will not permit the standard to be maintained in the future because of anticipated growth of industrial capacity and consequently, of emissions. In either instance, the goal of the Minerals, Processing, and Manufacturing Subprogram is to provide technically and economically feasible processes that allow attainment and maintenance of AAQS.

New Source Performance Standards (NSPS) for the six criteria pollutants have been promulgated for 12 industries and proposed for 8 others under the CAA. The expectation is that another 25 criteria pollutants will be promulgated between 1976 and 1978 for other industrial categories. The need for a technology R,D&D program to support these and future standards is critical.

EPA has already established or is in the process of setting emission standards for certain other hazardous (noncriteria) pollutants such as mercury, fluorides, asbestos, vinyl chloride, bischloromethyl ether and hexachlorobenzene. Because of inadequate understanding of effects of industrial chemicals and materials in the environment, it is likely that the pollutant-of-the-month syndrome will continue. At this time, at least 17 sources have already been identified that emit toxic materials in quantities that are probably of concern.

Experience in dealing with hazardous materials (e.g., asbestos and vinyl chloride) indicates that there is usually insufficient health effects data to establish a "safe" exposure level. EPA must therefore rely on a technology-based standard to ensure that exposures do not present substantial risks to people. Anticipatory R,D&D on control of emissions of potentially hazardous materials can serve the Nation well by providing assessments for the feasibility of control of such materials.

Finally, the FWPCA requires that a list of hazardous materials be issued and that the list serve as a basis for recovery for damages resulting from spill of such materials. The expectation is that over 500, primarily industrial materials, will be identified. The capability to contain and clean-up spills of so many materials is just beginning to emerge from the hazardous spills R,D&D activity.

Status of Technology

To date, this technology R,D&D has provided the technical basis for an estimated 100 industrial categories at the Best Practical Technology (1977) and Best Available Treatment (1983) levels of control. Additional technology gaps and associated R,D&D needs, if any, for specified Best Practical Technology levels may be identified in legal tests of regulations. There are, however, R,D&D requirements for Best Available Technology, New Source Performance Standards, Pretreatment Standards and Toxic Standards.

The data base on which decisions can be made for industrial air pollution control is generally weak. Consequently, a large assessment program has been initiated to determine what sources may require control technology R,D&D in the future. A complicating factor is the large number of industrial sources that can be addressed. To provide priorities for air pollution control efforts, available emissions data (calculated, measured, or otherwise estimated) were used to calculate a relative ranking of 600 industries. The ranking took into account the specific pollutants emitted, the relative toxicity of the pollutant, the physical configuration of the emitting source and the population in close proximity to the source. As a result, more detailed assessments have been started for the 40 highest priority industries. New industries will be added to the study list as ongoing assessments are completed--subject to availability of funds. Further, multimedia assessments to fully consider intermedia transfers are being initiated.

Five-Year Plan

To significantly enhance protection of the environment from industrial pollution sources by the mid 1980's, the Minerals, Processing, and Manufacturing Subprogram is recognized as a high priority R,D&D area. Because of the time restraints in the FWPCA to achieve the stringent control levels established and anticipated timing of additional New Source Performance and Hazardous Materials Standards and new Toxic Substances Standards, R&D must be accelerated if industry is to meet these regulations and standards in FY 1978 and FY 1979. Resources can be substantially reduced in FY 1980 and beyond as efforts move beyond demonstration to technology transfer to industries that can benefit from the intensive ongoing R,D&D effort. By anticipating such a "spike" increase in resources for FY 1978 and FY 1979, it will be possible to plan cooperative programs with the affected industries to maximize use of total resources--both federal and private.

Methods that effectively control all wastes--including air, water and solid waste pollution--from large industrial sources are needed.

CREDIT: EPA/DOCUMERICA - Paul Sequeira

A major industrial air and water polluter is the iron and steel industry. Devices suitable for retrofit to existing coke ovens have been demonstrated for control of air emissions during charging and pushing operations. A system for controlling both air and water discharge from pushing and quenching operations is scheduled for completion in FY 1976 and will serve in part as the basis for a New Source Performance Standard. It is expected that in FY 1977, an integrated total environmental control project will be initiated for a fully integrated iron and steel facility. This project will treat both air and water pollution and should be completed by FY 1980.

Fine particulates also present a serious problem to the iron and steel industry. For that reason, plans for two demonstrations of different advanced control techniques will be initiated during FY 1976 and completed during the following fiscal year. One of these demonstrations will involve fine particulate control in the steel making process and the other will be included in production of ferroalloys. The expectation is that an electrostatic precipitator system and flux force condensation or other advanced system will be demonstrated for fine particulate control beginning in FY 1977.

In metal finishing and electroplating, full-scale demonstrations of acid retardation and ion exchange to recover phosphoric acid from bright aluminum wastewaters containing cyanide and reverse-osmosis treatment for nickel plating wastewater, will be completed in FY 1976. Accelerated efforts on ways to treat highly toxic and often heavy-metal laden wastes from these industries will be launched in FY 1978 and FY 1979.

Another high priority industry is the petrochemical industry. Demonstration of closed cycle technology to control pollution from this industry will be initiated. Petrochemical facilities are major emitters of organo-nitrogen compounds into waters and major sources of hydrocarbon atmospheric emissions. Three investigations to be completed in FY 1976 include: (a) use of automated control of the novel "BTOX" system for treatment of organically contaminated brines generated in glycol production, (b) the development of total recycle systems for waste brines containing refractory organics and (c) the development of treatment and control technology for refractory petrochemical wastes. These studies will serve as the basis for full-scale industrial demonstrations to be undertaken with industry beginning in FY 1978.

Closely associated with the petrochemical waste treatment program are R,D&D efforts on disposition of chlorinated waste residues produced in purififying chlorinated solvents. Engineering design studies, including specifications and costs, are currently underway for design, construction and operation of a full-scale chlorolysis regional waste disposal facility. The demonstration phase of this facility should begin in FY 1977. Utilization of this process will substantially reduce discharge of hazardous residues to the environment and effectively eliminate a major source of chlorinated hydrocarbons to receiving streams and groundwater.

During FY 1976, R,D&D efforts in the rubber, plastic and inorganic chemicals areas will lead to: (a) a demonstration of removal of nitrocellulosic fines by ultrafiltration allowing water reuse and nitrocellulose recovery (this technique has application to both explosives and plastics industrial wastewaters); (b) demonstration of Best Available Technology for wastewater treatment in the synthetic rubber industry; (c) an assessment of the technology available for the alumina refining industry (Bayer Process Red Muds); and (d) a pilot demonstration of industrial wastewater renovation by an evaporative process that removes dissolved solids (this approach has application to acid mine drainage water, powerplant cooling water and blowdown streams). These efforts will serve as the basis for full-scale industrial demonstrations beginning in FY 1978.

Also in FY 1976, the results of a full-scale demonstration of use of activated carbon in conjunction with air flotation to treat wastewaters from a naval stores (wood chemicals) production facility, are to be published. This carbon absorption unit is the largest industrial treatment facility of its kind in the world and will serve as the prototype for other industrial units.

The toxic pollutant technology demonstration program has developed to the point where studies of pilot to full-scale processes are underway to treat wastewaters from the manufacture of PCBs, endrin, heptachlor, chlordane and DDT. Continued research is necessary because these and other chemicals may still be produced and exported even while domestic use should be significantly reduced. This research will be expanded to include toxaphene, aldrin, dieldrin and other toxic streams in FY 1978 and FY 1979.

Maximum closure of the process water loop in an integrated neutral semi-chemical pulp and paperboard mill will be achieved in FY 1976. In addition, a 300 ton-per-day multi-stage oxygen bleaching system for producing hardwood kraft pulp will be demonstrated. Not only will the latter project be the first demonstration of oxygen bleaching in North America, but it will also be the first application of integration of oxygen technology into an entire mill system. Kraft pulp mill odor control projects for both retrofit and new recovery boilers are being completed. These demonstrations represent state-of-the-art control using process modifications for reduced sulfur compounds from recovery furnaces. The use of activated carbon treatment of kraft pulp bleaching effluents together with achievement of economical production of activated carbon as a by-product from kraft pulping liquors, is also being completed. These technology developments and demonstrations will be transferred to the pulp and paper industry.

In the food processing area, demonstration of the reuse of poultry and food and vegetable processing waters will be completed, including evaluation of acceptability of using those treated waters as a recycled stream. These projects will be "pathfinders" for similar approaches in other food processing industries.

In FY 1977, a demonstration of nitrogen-compound removal from meat packing plant effluents to meet Best Available Technology limits will be completed. The main emphasis in the food processing area will be on reduction and elimination of water discharges by demonstration in selected high water use segments of the industries. By-product recovery for segments of the industry--potato processing and beverage production--will be initiated in the late 1970's and completed in 1980.

A manual for the design of rendering-plant odor-control scrubbers will be distributed this year. This manual is the result of a joint Industry/EPA study to pfovide technical support for odor control programs. Air pollution control of fugitive dusts from sources such as rendering plants will be completed in FY 1978.

The Hazardous Spills work is in the process of demonstrating three systems for the treatment, containment and collection of hazardous spills. To be completed in FY 1976 are: (a) full-scale demonstration of a mobile 250 gallons-per-minute "dynactor" treatment system that has broad range application to spills containing toxic metals, inorganics and organics and pesticides; (b) development and demonstration of an in situ foam diking system for spills containment; and (c) demonstration of a self-contained collection bag system for containing hazardous spills. In future years, technology will be developed and demonstrated to contain and clean-up hazardous materials spills on land and for those resulting in air pollution incidents.

Renewable Resources Industry

Subprogram Description

The renewable resources industry includes food, fiber, and wood production and related activities ranging from agricultural production through harvesting. This research area encompasses: (a) methods for predicting the water quality impact of various agriculture and silviculture practices to aid in establishment of water quality standards; and to assess the impact of alternate management methods: (b) Best Management Practice (BMP) alternatives designed to reduce or prevent runoff of pollution discharges or emissions that adversely affect air, land or water, including cost-effective determinations and evaluation of social and economic impacts; (c) assessment of probable trends in production of renewable resources and their resulting socio-economic and environmental impacts; and (d) development of nonchemical pest management controls to reduce problems of runoff from agricultural pesticides.

The expectation is that pressure will mount for the U.S. to significantly increase agricultural production in the last quarter of this century. This pressure will likely mount as the production-to-consumption gap of highly populated underdeveloped countries widens, as developed countries attain increased affluence and as world population increases. Environmental problems of a broad scope are likely to accompany any drastic efforts to increase agricultural production in the U.S. Moreover, significant conflicts may arise between energy development, production and uses, community development and renewable resources activities. The long-term problem then, for the U.S. will be to increase agricultural production with minimal environmental degradation and conflict with other national goals.

The long-term research in this area will be to: (a) develop the capability to assess and predict environmental effects of existing and advanced approaches to increased production of each renewable resource and between resources at the local, regional, and national levels; and (b) develop cost-effective alternative technological, management and institutional approaches to assure increased production at the least environmental cost.

The more immediate problem confronting EPA evolves from P.L. 92-500 and the need to manage discharges from nonpoint sources. The problem is: To provide State and local water quality management agencies with tools they need to carry out their area-wide waste management responsibilities under Section 208, P.L. 92-500. The tools include: (a) guidelines for identifying, assessing and evaluating the nature and extent of agricultural and silvicultural sources of pollution, and (b) processes, procedures and methods to manage and control pollution from these sources, as delineated under Section 304(e) of FWPCA.

ORD has conducted research that will partially address and provide a base for some aspects of long-term renewable resource objectives. These efforts, have previously been limited in scope and designed to provide operational support needed to solve specific near-term problems. Consequently, an assessment of short- and long-term trends in agricultural production as they affect environmental quality is being initiated to more fully address the longer-term research needs.

EPA has published guidelines on methods to identify significant agriculture and nonpoint source activities. In the near future, EPA will publish Best Management Practice (BMP) position papers for use by regional and State personnel. ORD has an ongoing activity to develop predictive techniques to determine pollutant loadings as a function of measurable source characteristics. It has also developed methods to control or manage wastes and runoff from specific agriculture sources for limited areas of the Nation. Wide variation in climate, rainfall and hydrology, geologic conditions and production practice preclude the rapid development of comprehensive alternative management practices in all areas.

Other federal agencies, such as USDA, have been involved in related activities. But their efforts have not been principally directed at environmental protection. For example, the Soil Conservation Service (SCS) has developed soil conservation measures to prevent soil loss. The role of these individual measures in meeting water quality standards, however, needs to be determined in terms of their cost/benefit and socio-economic impacts.

The near-term approach in the Renewable Resources Industry Subprogram concentrates on five activities: animal production, irrigated crop production, nonirrigated crop production, silviculture and alternative pest management.

Animal Production

Major emphasis is on land application of waste from confined animal production. This includes the development of methodologies to determine environmentally safe and cost-effective waste application technologies for optimum crop utilization or for disposal alone where crop production is not the governing factor. To be included are: impacts on surface and groundwater; long-term effects on soils and productivity; potential health effects; rates of application of technology as functions of climate, slope, soil, crop, etc.; and timing of application.

A second problem area is the development of cost-effective waste management systems for animal production operations. Included are: controlling runoff from small confinement areas, barnyards, and pastures; preparation of guidelines for storage of runoff and pump-out of retention facilities; and assessment of problems from animals with access to surface waters.

A third problem area is that of waste disposal where land application is not feasible. Emphasis is on evaluation of environmental impacts and comparative economics of alternatives to land disposal for handling of animal wastes.

Irrigated Crop Production

Studies on this topic include: evaluation of the effect of present irrigation practices on salt loads entering river systems, particularly through groundwater drainage systems; development of prediction techniques that apply to water quality problems of irrigation return flow; in cooperation with the Bureau of Reclamation, a demonstration that improved farm water management offers a feasible means to minimize salt and nutrient degradation of return flow without sacrificing crop yields; development and demonstration of fundamental technology required for pollution control in irrigated areas, including structural changes, on-farm water management and new concepts relating to solute movement and storage; and evaluation of the legal, economic, and institutional constraints to improved water management.

Nonirrigated Crop Production

Studies are underway in this area to: evaluate pollution aspects of existing agricultural practices and technical efficiency and cost-effectiveness of available control methods; recommend changes in practices to achieve environmental improvement; develop verified pesticide and plant nutrient mathematical models with watershed and gross basin-wide predictive and simulative capability and nationwide applicability for all major pesticides and plant nutrients (nitrogen and phosphorus); based on the models, formulate cost-effective regional control systems to prevent pesticide and plant nutrient pollution at their sources; and assess reduction in pollutant loading for any specified management or engineering practice and legal constraint.

Silviculture

The emphasis here is on: evaluation of pollutants and their sources resulting from current forest management activities; developing cost-effective structural and nonstructural practices designed to reduce pollution;

Alternative management methods for controlling runoff due to timber harvesting practices are being investigated in the Renewable Resources Area.

CREDIT: EPA/DOCUMERICA - Thomas Sennett

developing verified pollutant runoff models with watershed and basin-wide capabilities to determine potential pollution loads and to evaluate and optimize use of management systems; and based on modeling efforts, legal constraints and socio-economic factors, developing control systems to meet 1983 water quality goals.

Alternative Pest Management

The objective here is to develop alternative nonchemical methodologies for pest control for a variety of crops and conditions. To do this will require development of various strategies and tactics of pest population regulation and control in major fruit and vegetable ecosystems. These ecosystems are to be studied either simultaneously as interacting groups or individually where control of insect and weed pests is needed using a variety of nonpesticide means. Such means may include insect and plant pathogens, e.g., viruses, bacteria and insect pheremones and harmones. Strategies for nonpesticide control of urban pests, such as cockroaches and mosquitoes, need development. This work is coordinated with the National Science Foundation and the U.S. Department of Agriculture.

FY 1976 Plan

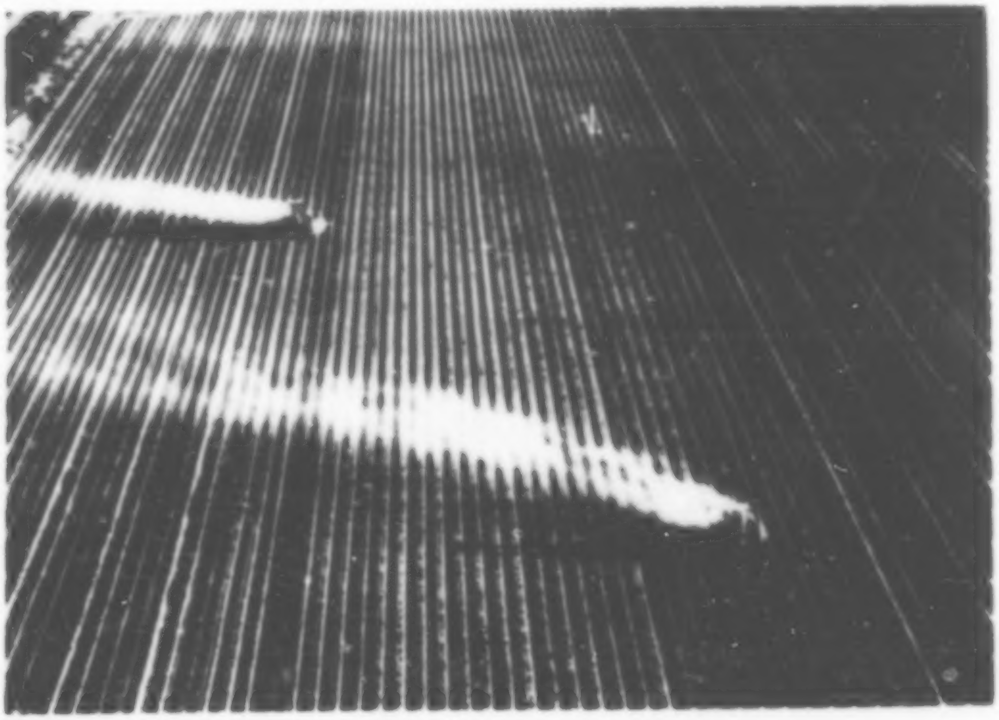
Of this overall Renewable Resources Subprogram, major FY 1976 outputs will be as follows:

- Publication of an agricultural chemicals user's manual that assesses existing farm practices on their environmental protecting merits.
- Assessment of cost-effectiveness of recommended soil conservation practices (sediment control) for water quality control.
- Completion of a limited assessment report on the magnitude of potential problems and development of initial guidelines for cost-effective enforcement of pesticide regulations at the producer, distributor and user levels (for use by State agencies in designing their programs and allocating resources).
- Evaluation of the water pollution potential of animal wastes applied to land for optimum crop production.

- Evaluation of environmental impacts from wastes generated by unconfined animal production.
- Summary of animal waste utilization (resource recovery) practices, including their costs and comparative economic evaluation relative to land application of these wastes.
- Completion of a state-of-the-art document assessing the technology and data base for development of predictive techniques to determine water pollutant loading from forested watersheds.

Five-Year Plan

In FY 1977, subjects to be addressed by manuals developed in animal production research areas include: potential runoff and resulting pollution from land application of wastes, cost-effective techniques of land application and measures for management of runoff from land application, and cost-effective systems to manage pollution from non-NPDES operations (including waste holding structures).



Trends in agricultural practices are being watched closely to anticipate possible environmental impacts.
CREDIT: EPA/DOCUMERICA - Charles O'Rear

Efforts to complete a total-package salinity control project in the upper Colorado River Basin, including evaluation of various salinity control measures studied, will continue. To date, the demonstration of management practices is nearing completion. Economic and institutional constraints of irrigation water management reform and salinity control will be evaluated. And a multilevel optimization model for cost-effective salinity control measures integrating desalination will be developed in the area of irrigated crop production.

Completion of verification of and development of a user's manual for both pesticide and plant nutrient watershed models for the Piedmont and Great Lake Regions will be achieved for nonirrigated crop production. And efforts related to silviculture will be continued.

Plans in future years call for: continuation and intensification of ongoing projects; increased activity in assessment of short- and long-term practices in agricultural production as they impact on environmental quality including (1) specific analysis of environmental impacts from agricultural systems of highest priority, (2) conversion of marginal land to cropland and (3) investigation of social and economic aspects of pollution control/management methods in the renewable resource industry. Major emphasis will be on identifying emerging agronomic trends that can be made environmentally sound before coming into general use to ease the impact of environmental controls on agricultural economy and socio-institutional systems. Annual reports will be developed assessing recent developments in agriculture (i.e., irrigated and nonirrigated crop production, animal production and silviculture) and emphasizing socio-economic aspects of trends on a nationwide basis.

Overview

Several problem areas that EPA must address can be linked together in a group because of their significance in community environmental management. Three research subprograms here are:

- Waste Management
- Water Supply
- Environmental Management.

The Waste Management Subprogram focuses on prevention, control, treatment and management of pollution produced by community, residential or other nonindustrial activities. This research concerns municipal and domestic wastewater and collection/transport systems, urban land surface runoff, municipal solid wastes and associated air pollutants.

The major thrusts of the solid waste research include: preparation of comprehensive effects documents designed to support regulatory efforts for hazardous wastes disposal, control technology development for treatment and disposal of pesticides and other toxic chemicals, investigations to determine the potential for migration through soils of hazardous industrial wastes, studies to evaluate environmental effects of sanitary landfills and development of resources recovery systems for energy and material retrieval.

A major effort is underway to provide dependable and safe supplies of drinking water. This includes work on health effects that result directly or indirectly from contaminants in drinking water. The Water Supply Subprogram provides for development of analytical methods to assess drinking water quality and development of water treatment processes to remove and reduce undesirable contaminants in water supplies that current methods miss.

Water supply research includes three areas of concentration: health effects, water treatment and systems management and groundwater management. The major objective of water supply health effects research is to develop valid criteria for setting drinking water quality standards.

Specifically, this research will provide scientific knowledge necessary to establish standards for organic, inorganic and microbiological contaminants in drinking water. The primary purpose of water supply control technology R&D is to evaluate, improve and develop cost-effective control techology necessary to achieve drinking water standards. This involves both the adaptation of large-scale technology to small water supply streams and development of new or special technologies.

The objective of the Environmental Management Subprogram is to provide regional environmental planners and managers with methods to determine feasible alternative solutions to specific environmental problems and to provide techniques for selecting least-cost solutions. The research focuses on development of improved multimedia planning techniques, improved methods for collection and analysis of environmental quality and economic information, evaluation of alternative institutional arrangements and development of comprehensive systems analysis and evaluation methodologies.

The program output will be user-oriented and include information needed and decision methodology required to select and implement effective environmental quality control programs on a community and regional level.

Following is a description of the three subprograms and main outputs that comprise the Public Sector Activities Program.

Waste Management

Subprogram Description

The domestic, commercial, recreational and other nonindustrial activities of the Nation's communities are major sources of pollution and degradation of environmental quality. These many and diverse communities vary from isolated rural settlements and recreational areas to sprawling suburban developments and large, concentrated urban areas. Community activities, normally under management of State and local governments produce pollutants that are discharged into the Nation's surface and groundwater from sewered wastewaters, runoff of rain and melted snow with pollutants from the land's surface and percolation of pollutants from subsurface disposal sites such as home septic systems and public or private landfills. Also included are emissions to air from many sources.

Through a diverse and complex set of laws, EPA has a number of ways to approach public sector problems. The most conspicuous and direct federal mechanism is the massive Construction Grants Program coupled with the National Pollution Discharge Elimination System authorized by P.L. 92-500. The ultimate solution to these problems, however, may well be through more decentralized programs, exemplified by Section 208 of P.L. 92-500, that give responsibility for planning and implementing environmental controls or management systems to State and local authorities with EPA providing guidelines and assistance.

The Waste Management Subprogram is designed to support efforts by EPA and State and local governments to develop and demonstrate specific pollution control technologies or management systems. It also provides technical tools to assess local problems and select appropriate management options. Based on current needs, this subprogram is organized into five distinct research areas:

- Wastewater Treatment Technology
- Soil Treatment Systems
- Runoff Pollution Control
- Community Wastewater Systems Management
- Solid and Hazardous Waste Management

Wastewater Treatment Technology

This effort is focused primarily on technology for publicly-owned treatment works. It supports the needs of Construction Grants Programs through (1) improving performance and reliability and reducing costs and energy demands of available technology (2) providing solutions for current technological inadequacies such as sludge handling and disposal and (3) developing technologies for removal requirements exceeding secondary treatment such as nutrient removal, all necessary to achieve the 1983 goals of P.L. 92-500.

This research also deals with technologies to treat and dispose of "small flow" domestic waste systems such as those from individual homes not connected to sewers or from small recreational areas.

Soil Treatment Systems

In some places, an attractive alternative to mechnical devices used in wastewater treatment is land application of effluents with resulting removal of pollutants by soil. Moreover, land disposal is a promising method for disposing of and utilizing sludges from wastewater treatment systems. This effort focuses on (1) development and evaluation of the cost, performance and practicability of land application systems, especially those involving beneficial uses such as crop irrigation, (2) assessment of public health, socio-economic and other environmental factors related to design and operation of land application systems and (3) examination of potential of other "natural" systems, such as marshes or aquaculture units for removal of pollutants from wastewater.

Sludge disposal is a serious problem for many communities. Here sludge is being disposed in a reclaimed strip mine.

CREDIT: EPA/DOCUMERICA - Frank Alexsandruwicz

Runoff Pollution Control

Although current water pollution abatement efforts are directed primarily toward point sources of urban pollution, increasing attention must be given to land runoff of rainfall and melted snow. Such attention can be given either directly or with combined or storm sewers and modifications of the land's surface to influence this runoff. Broad, current indices indicate that almost one-third of the stream segments of the Nation are significantly polluted by combined sewage overflows and urban runoff.

This effort is directed towards development and evaluation of cost-effective approaches for control of abatement of pollution resulting from runoff of rainfall and melted snow and activities that influence this runoff by modifying the land's surface. Included are: (1) tools for assessing runoff problems in specific areas and selecting appropriate management options; (2) development and evaluation of management systems ranging from source control through flow attenuation with systems management by means of storage or routing to treatment of sewered discharges and (3) development of solutions to specific problems such as sewer infiltration.

Community Wastewater Systems Management

This effort includes research activities to combine wastewater treatment technology, soil treatment systems and runoff pollution control into integrated, cost-effective, community wastewater management systems. It also assures that activities related to each of these efforts are effectively coordinated.

Solid and Hazardous Waste Management

Communities across the Nation are faced with increasingly costly and intransigent problems because of the enormous volume and diversity of wastes that are either directly emitted to the air, directly discharged into sewers or washed away by land runoff. Most of these wastes find their way into the community solid waste management or disposal systems. Research efforts on this problem are directed to three areas: (1) development and evaluation of means to handle and dispose of municipal solid waste, especially as this influences air and water quality, (2) evaluation of the overall impacts of and the development of criteria for land disposal of wastes and (3) development of community or area-wide waste management systems with primary emphasis on resource recovery.

FY 1976 Plan

During FY 1976, major emphasis in the wastewater area will focus on technological problems associated with the Construction Grants Program. Foremost among these is processing and disposal of sludges from wastewater treatment systems. Specific projects will deal with evaluation of sludge composting, combined refuse and sludge composting and landfill and combined refuse and sludge pyrolysis and wet oxidation. Special attention will be given to possible beneficial uses of products from these sludge processing systems.

Specific projects will also deal with upgrading the performance of existing treatment works to reduce costs of new construction. An example of this is the development of technology enabling many existing treatment lagoons to meet secondary treatment requirements, alleviating the need for installation of entirely new treatment systems. Specific emphasis will also be given to evaluation of alternative wastewater disinfection technologies to avoid adverse environmental side effects of chlorine.

Responsible waste management will help conserve natural resources as well as reduce adverse environmental impacts associated with waste disposal and resource extraction.

CREDIT: EPA/DOCUMERICA - Bill Shrout

Secondary effort will be directed toward development and cost reduction of nitrogen removal methods, cost reduction and performance improvement through instrumentation and automation of treatment systems and evaluation of "small flows" treatment systems for nonsewered areas.

Soil Treatment efforts in FY 1976 will continue to focus on evalution of systems for irrigation, infiltration and development of promising overland flow technology for effluent treatment.

Runoff Pollution Control area efforts will concentrate on consolidation of results from specific ongoing and completed combined sewer overflow control projects into integrated management systems, improvement of methods for assessing the local and regional impact of urban and suburban stormwater discharges and need for their control and evaluation of sediment control from urban and suburban developments.

This research will be limited to bench and pilot-scale development and evaluation of existing full-scale systems.

Major thrusts of Solid and Hazardous Wastes efforts in FY 1976 continue on evaluation of environmental impacts of sanitary landfills. This will include possible migration through soils of hazardous or other polluting wastes, development of technologies for treatment and disposal of specific hazardous wastes such as pesticides, the preparation of comprehensive effects documents designed to support a possible regulatory program for hazardous wastes disposal and evaluation of promising resource recovery options.

Five-Year Plan

Wastewater Management

During the FY 1977 - FY 1980 period, continued emphasis will be given to development and evaluation of cost-effective methods for sludge processing, utilization and disposal; soil treatment systems; alternative disinfection techniques; upgrading of existing treatment systems; and consolidation of results from available combined sewer overflow control technology.

Problems that will receive increased attention during this period include:

- Methods to improve performance and reliability and reduce costs of existing treatment systems with instrumentation, automation and improved operation and maintenance procedures
- Integrated dry- and wet-weather management systems for urban wastewaters.
- Treatment technologies for removal requirements in excess of secondary treatment as needed to achieve the goals of P.L. 92-500.
- Treatment technologies for specific discharge conditions such as ocean outfalls that may differ in requirements from current secondary treatment levels.
- Development of nonstructural approaches to urban and suburban runoff control, including methods for flow attenuation that can be integrated into area-wide wastewater management and land use programs.

Effective and safe methods to dispose of hazardous wastes are being developed.

CREDIT: EPA/DOCUMERICA - Gene Daniels

Solid and Hazardous Wastes

Efforts in evaluating and developing alternatives for hazardous wastes disposal and in evaluating envirnmental impacts of landfills will continue.

Increased effort will focus on developing comprehensive area or community-wide waste management systems. This will include recovery of materials and energy from wastes and integration of individual private and public waste collection, processing and disposal systems.

Water Supply

Subprogram Description

The discovery of many organic materials in much of the Nation's drinking water, with their associated health implications, lead to enactment of P.L. 92-523, The Safe Drinking Water Act. The Water Supply Subprogram supports implementation of this Act by EPA and the States.

Activities of this subprogram include R&D of dependable and safe supplies of drinking water. Attention is also given to health effects of contaminants in drinking water. This includes development of analytical methods to assess quality of drinking water and water treatment processes to remove and reduce undesirable contaminants current methods fail to remove.

Major goals of this research include development of valid criteria for drinking water quality standards. Also included is development of scientific knowledge to establish standards for organic, inorganic and microbiological contaminants of drinking water and evaluation, improvement, and development of control technology to economically attain standards for drinking water. This involves both adaptation of large-scale technology to small water systems and development of new or special technologies.

The products of these activities will include:

- Improved methods to identify and measure contaminants in drinking water and identify sources of contaminants.

- Improved methods to identify and measure health effects of contaminats in drinking water.

- New or improved methods of treating raw water to prepare it for drinking involving improving the efficiency of water treatment and contaminant removal.

- Improved ways to provide dependable supplies of safe drinking water (includes water purification and distribution improvements and methods to assess health-related hazards of drinking water).

- Improved ways to protect groundwater sources of public water supplies from contamination.

FY 1976 Plan

The following will receive emphasis in FY 1976:

Water Treatment and Systems Management

Efforts will include evaluating and demonstrating pilot-scale technologies to inactivate germs and to remove potentially toxic or aesthetically displeasing contaminants, achieving compliance with present and future drinking water quality standards. Improved methods of operation will be developed for new and existing water supply facilities. Technologies to remove organic contaminants and alternatives to existing chlorination methods will receive special attention.

Water Supply Health Effects

Evaluation of potential health hazards of organics and the validity of possible general indicators for organics such as carbon chloriform extraction and alternatives to that method, will get primary emphasis. There will also be efforts to evaluate the nature, concentration and effects of inorganic and microbiological contaminants of drinking water. Coordinating ORD's expanded activities in this area with other federal agencies such as the National Cancer Institute will be important, too.

Measurement and Identification Techniques

Sensitive measurement methods for low concentration levels of many toxic and carcinogenic substances must be developed. This requires special concentration and separation techniques. Present methods for organics only detect small amounts of total organic content. Efforts to develop methods for organics will increase. Procedures for identification of sources of water supply contaminants will be developed.

Development of virus detection methods and rapid instrumentation methods for detection of inorganic substances will receive more attention. To carry through and complement current program objectives in FY 1976, studies will continue or be initiated to determine health effects of organics, tin, manganese, cadmium, arsenic, selenium, barium, molybdenum, antimony, nitrates and asbestos.

The assurance of a safe and dependable supply of drinking water is the driving force of ORD's water supply research.

CREDIT: EPA/DOCUMERICA - Boyd Norton

Groundwater Management

Focus here will be on limited efforts to evaluate the extent of impact on groundwater of: (a) abandoned injection or extraction wells; (b) intensive application of pesticides and fertilizers; and (c) surface disposal of contaminants in water recharge areas. Research will also be conducted to determine methods of protecting subsurface drinking water sources, to evaluate formation pressure increases caused by underground injection, to develop a model that can predict and estimate the impact of such increases and to determine the effects of pressure increases on waste migration.

Because of high cost, groundwater research will generally be limited to: (1) evaluation of current and projected groundwater problems; (2) maintenance of technical expertise to advise the EPA on policy and regulatory matters; and (3) research on the selected priority problems described above.

Five-Year Plan

Increased efforts in measurement and identification programs will focus on development of practical techniques to identify measure and determine sources of contaminants (particularly organic substances and viral agents) in drinking water. Techniques will be disigned for use by State and local public health officials responsible for safeguarding public drinking water supplies.

Defensible health effects data for organic, inorganic, and microbiological contaminants of drinking water will be developed through short- and long-term toxicological studies and comparative epidemiological studies. Future efforts will be evaluated and redirected as necessary when the evaluation by the National Academy of Sciences of health effects of contaminated drinking water, as required by P.L. 92-523, is completed.

Studies will be continued or initiated on removal and inactivation of camium, lead, asbestos, nitrate, radium, organic compounds, bacteria and viruses. In continuing the FY 1976 program, EPA intends to determine how to prevent water quality deterioration while distributing drinking water. Technology applicable to small water supply systems will be emphasized.

There will be a substantial R&D effort to control organic contaminants in drinking water. Halogenated organics formation mechanisms in normal disinfection practices will be determined and control methods developed. Chlorine disinfection alternatives will be thoroughly studied in the near-term. Candidate alternative disinfectants are ozone and ultraviolet light.

Increased effort are planned on removal and disposal of organics. Also in FY 1977-FY 1980, studies will continue to provide waste disposal site-selection criteria and groundwater basin management.

Environmental Management

Subprogram Description

EPA's legislative mandates generally delegate authority to State or designated regional and local agencies to implement requirements of federal environmental quality programs. Included in these requirements are development of State-wide continuous planning processes (FWPCA, Section 208), water quality facilities plans (FWPCA, Section 201), solid waste disposal plans (SWDA, Section 207), State air quality implementation plans (CAA, Section 110) and plans for air quality maintenance. To implement these programs, environmental agencies at regional and local levels are required to analyze regional development objectives, population, economic growth projections, land use and transportation patterns for direct and indirect effects on environmental quality.

Strategies to achieve specified environmental objectives are varied and complex. State, local and regional institutions often lack capability to analyze and evaluate alternative strategies and develop coordinated procedures from a chosen strategy. For that reason, EPA will develop sets of alternative solutions that are applicable to various community environmental problems and efficient within the constraints of a community's economic resources and political realities. Methods to select and analyze environmental management options under local conditions will also be developed.

The goal of the Environmental Management Subprogram is to give regional environmental planners and managers methods to determine feasible alternative solutions to specific environmental problems and provide techniques to select least-cost solutions. The research focuses on development of improved multimedia planning techniques, improved methods for collection and analysis of environmental quality and economic information, evaluation of alternative institutional arrangements and development of comprehensive systems analysis and evaluation methods. Important efforts involve:

- Investigation of linkages among various residuals (solids, liquids and gases) generated by and discharged by community activities.
- Design of integrated environmental management systems, including analytical planning techniques and analysis of alternative implementation techniques. Administrative and institutional considerations will also receive attention.
- Evaluation of impacts (both positive and negative) on all media (air, water and land) of single-media pollution control strategies.
- Development of technical guidance for applying available information, including methods to assess problems and selection of available management options, to give local planners and policy-makers access to available information.

The subprogram output will be user-oriented and will include information needed and decision methodology required to select and implement effective environmental quality control programs on a community and regional level.

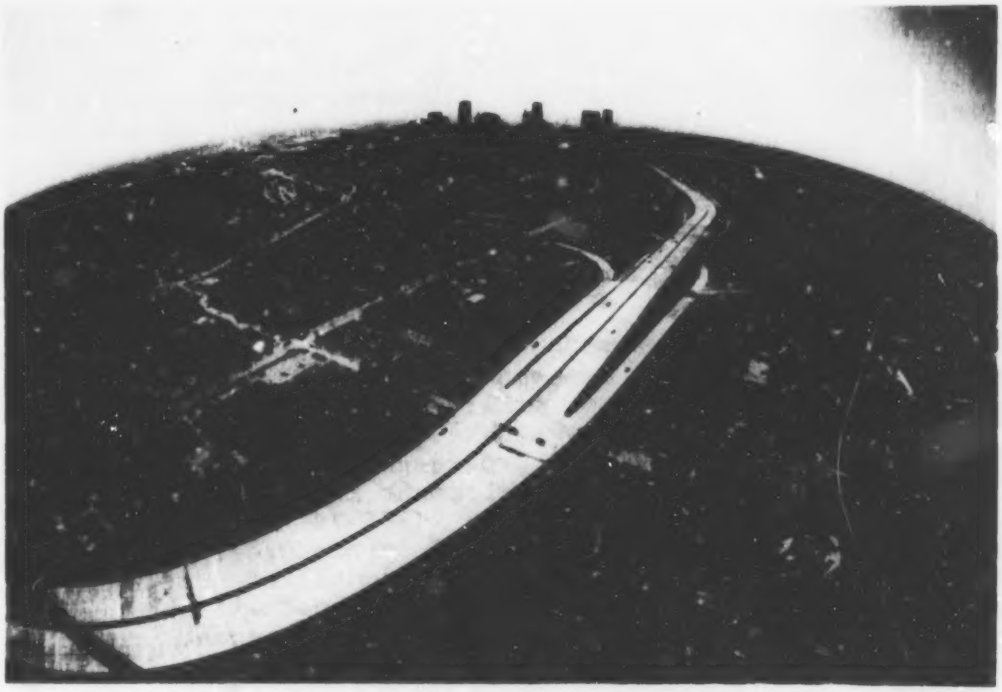
FY 1976 Plan

Comprehensive Planning Guidelines

Outputs sought in this area include: (a) scientific, technical and economic information on environmental and socio-economic links between EPA and other federal planning requirements for use by EPA offices to assist them in developing coordinated planning guidelines and (b) comprehensive, regional environmental management handbook for use by nonfederal planning agencies containing advice on available types of economic and environmental forecasting procedures, types of data necessary to effectively use such procedures, the order in which different environmental and economic problems should be analyzed, ways to present various alternatives to the public, decision-making procedures and methods to make all environmental plans consistent with other federal planning requirements.

Implementation Methods

Outputs desired here include tools to implement environmental management strategies developed in the above-mentioned planning processes. State or local governments can choose from the following basic concepts of implementation: (a) traditional regulatory procedures, i.e., laws, ordinances, permits, zoning; (b) economic incentive concepts, i.e., fines, emission and effluent charges, differential property tax rates, subsidies; (c) information and volunteerism concepts, i.e., labeling programs, increased information dissemination through mass media; and (d) government-induced technological changes, i.e., container controls, subsidized recycling programs, subsidized mass transportation systems.



The development of cost-effective tools for implementing comprehensive, multimedia environmental standards and regulations is the objective of environmental management research.

CREDIT: EPA/DOCUMERICA - Bob Smith

Each of these implementation procedures has a different level of feasibility, public acceptability and cost-effectiveness based on the type of environmental problem involved and the locale of the community where implementation is attempted. Because of the large number of problems at national, State and local levels, this research is critical. High priority topics in this area include implementation of land use controls for nonpoint source water pollution control and mobile source air pollution control. It also includes overcoming socio-economic obstacles to development of soil treatment systems for community liquid and solid wastes.

Evaluation Methods

Goals for this research are improved efficiency in gathering environmental and economic information and better methods to use this information to define current problems and measure progress in achieving goals. This research will produce standard procedures for federal, State and local enviornmental managers to use to get the most useful information on relevant environmental problems.

Five-Year Plan

The research in FY 1977 and beyond will continue efforts to develop user-oriented management tools that explicitly define intermedia linkages, economic and energy effects and increased planning and implementation efficiency for integrated structural and nonstructural solutions to identified environmental problems. Key FY 1977 products will include the Regional Environmental Management (REM) Handbook, documentation of demonstrations of 208-AQMA coordinated planning and the population forecasting guide.

Other work will be done on development and extension of current single-media systems evaluation and performance modeling techniques to other media problems. Integrated methods to describe and evaluate total community costs and benefits of environmental programs will also be developed. The research will follow development and implementation of operational plans closely in 1976-78 to determine the effectiveness of newly-developed procedures. Additional research will be conducted on identified problem areas. And an updated version of the REM Handbook will be produced in FY 1980 in time for its use in a second round of environmental planning.

Research in the longer-term will concentrate on reducing costs of effective implementation and enforcement activities with emphasis on financial constraints. Also, as controls become more stringent in the early 1980's (BAT, transportation controls, etc.) several economics-based challenges are anticipated, e.g., via Section 302, P.L. 92-500. Methods to assure resolution of these challenges will be developed during the late 1970's.

MONITORING AND TECHNICAL SUPPORT PROGRAM

The Monitoring and Technical Support Program includes research, development and demonstration activities and direct assistance and support to all of EPA. The components of this Program include:

- Measurement Techniques and Equipment Development
- Quality Assurance.
- Technical Support.

Techniques and equipment development involves development, evaluation, and demonstration of field and laboratory measurement and monitoring methods and instrumentation. Efforts are directed toward achieving capability to identify and measure all pollutants of concern in the most cost-effective manner.

Techniques and equipment development over the long-term will continue to address methods and techniques for air, water and multimedia monitoring systems including advanced remote environmental monitoring systems.

Quality assurance serves all environmental monitoring activities of EPA. This activity focuses on standardizing measurement methods, providing standard reference materials and samples, developing quality control guidelines and manuals, onsite evaluation of analytical laboratories, inter-laboratory performance tests, monthly crosscheck samples studies, studies on methods for laboratory accreditation, studies on automation of laboratory instruments and data handling, and participation in regional quality control activities.

The quality assurance effort will expand in the future to assure that new requirements for water supply laboratories are met, to provide equivalency testing methods for State permit programs and to increase current efforts to upgrade quality control in EPA's monitoring programs.

Technical Support is the scientific and technical assistance the research program gives to other components of EPA by using the expertise of ORD personnel and available ORD facilities. This Subprogram includes responsibility to deliver results of ORD's efforts to its users by technical information dissemination. The technical support area had not been separately identified from the research program in previous years. The decision to make that identification reflects determination that R&D programs will be more responsive to immediate operational needs of other components of EPA.

Technical Supoort also includes minority institutions research support (MIRS). An effort to direct research grants to minority institutions in the area of environmental research is conducted by EPA. Minority institutions that have or can develop capability to conduct effective environmental research are actively sought, assisted in preparation of grant applications and encouraged to submit them.

Finally, technical support also includes the Science Advisory Board (SAB). The SAB was established to provide a strong, direct link between EPA's Administrator and the scientific community. The SAB's function is to provide independent technical reviews, to give advice on EPA's major scientific programs and to perform special task and program review assignments for EPA. This Board also gives advice on broad scientific and policy matters, new emerging environmental problems and assessments for specific research efforts to solve these problems.

Following are detailed descriptions of the various components of this Program and an identification of major outputs.

Measurement Techniques and Equipment Development

Subprogram Description

In administering the federal environmental protection laws, EPA is totally dependent on reliable, quantitative information on extent, concentration and trends of environmental pollution. This information, obtained through environmental monitoring, is necessary to:

- Determine if the presence of pollutants in the environment is likely to cause intolerable effects at existing levels.
- Quantify risks of pollutant exposure-effect relationships for important receptors.

- Understand linkages between significant sources of discharge and ambient levels of pollutants.

- Determine the need for and develop and implement measures to control point or nonpoint pollutant discharges to reduce receptor exposure to tolerable levels.

- Determine if pollutant discharge is in compliance with control requirements.

- Assess the effectiveness of pollution control programs.

The objective of the Measurement Techniques and Equipment Development Subprogram is to produce equipment and methods that are accurate, simple, standardized, cost-effective and in fulfillment of requirements for environmental monitoring by federal, State and local governments and by the private sector.

These methods must not only be applicable at lowest environmentally-significant ambient concentrations, but must also be applicable at higher concentrations that occur at pollutant sources.

Monitoring methods for the Health and Ecological Effects Program require high performance reliability at very low concentration levels necessary to relate adverse effects with low doses of pollutant in air, water and plant and animal tissues. Methods to measure impacts of heat, radiation and noise on economically or ecologically important receptors are also required. Highest priorities for such methods development are given to pollutants that are toxic, carcinogenic or otherwise hazardous.

Operational monitoring methodology development gives highest priority to performance reliability for pollutants that are regulated. These methodologies are intended for routine use in ambient environmental monitoring and for self-monitoring by point source dischargers and by those responsible for compliance monitoring.

The monitoring R&D includes design and optimization of monitoring systems and networks, development of airborne and remote sensing techniques, development of automated laboratories and data handling systems and development of environmental monitoring instrumentation. Further, state-of-the-art reviews, prototype instrumentation development and pioneering research studies related to development of new or significantly improved analytical methods or instrumentation, are supported. The approach usually taken in development of both air and water monitoring methods is to adapt or modify known measurement technology to meet field requirements.

FY 1976 Plan

Some representative examples of research priorities and outputs for FY 1976 follow:

EPA's Regional Offices and the Office of Water and Hazardous Materials (OWHM) and the States currently have requirements for improved methods in areas critical to NPDES enforcement related to water pollution. In response to these needs, development of methods to measure the concentrations of volatile organics and petroleum hydrocarbons, oil, grease and sediments, is scheduled for completion in FY 1976. Further, there is a continuous effort to correct deficiencies in candidate and reference methods for monitoring industrial wastewater discharges, sludges, ocean-disposed wastes, marine waters, ground waters and nonpoint sources.

A microbiological and biological methods manual will be completed in FY 1976. So will a new manual for analysis of pesticides in water and wastewater. These manuals are needed to assure that data from different monitoring and enforcement laboratories can be compared.

The FY 1976 Plan also includes development of methods to concentrate, separate and identify drinking-water contaminants, i.e., organics, viruses and elemental inorganics; measuring concentrations of asbestos fibers in water (to provide the Agency with an official interim method); quantifying algae levels related to sewage outfalls; simultaneous analysis of several toxic elements in water; broader identification and screening of organic compounds in water; incorprating carbamate and organophosphate pesticides into a more inclusive multi-residue procedure; analyzing multi-component chemicals such as polychlorinated biphenyls (PCB) and toxaphene; measuring concentrations of indicator organisms, phenols, and cyanides; and mass spectrometic identification of organic compounds whose spectra are not in the files.

The FY 1976 Plan also includes developmental work on remote sensing technology. Spectral signatures of water quality parameters and atmospheric effects on these signatures will be determined with a 30-channel spectrometer. An interim interpretation and analysis manual and keys to pollution sources will be published.

Also in FY 1976, a manual of groundwater monitoring guidelines is scheduled for completion.

Air pollutants scheduled for attention in FY 1976 include particulates, toxic trace metals, organics from chemical and petrochemical plants, PCB's, carcinogens, mutagens, sulfates and phenols. Specifications for performance of measurement systems for NOx, CO, total reducible sulfur particulate (TRS) and fluorides in Group III stationary emission sources will be published in FY 1976. These specifications are needed by States and industry to determine compliance with new stationary source performance standards.

The FY 1976 Plan also includes development of methods to: monitor airborne asbestos; relate plume opacity to mass concentration and identify and measure concentration of non-regulated nitrogen compounds from light duty vehicles. Further, the plan includes development of an instrument to measure sulfuric acid in ambient air and criteria for selecting "equivalent" methods for ambient air and stationary source measurements.

Helicopters can be used effectively in atmospheric studies for tracing pollutant paths and taking pollution samples.

CREDIT: EPA/DOCUMERICA - Gene Daniels

Five-Year Plan

The monitoring R&D is characterized as level-of-effort. Accordingly, much of the program looks the same for individual years in the five-year plan. Correcting deficiencies in candidate and reference monitoring methods and developing new methods as needs arise will continue to get attention with focus always on current high-priority pollutants.

However, there are some relatively long-range projects and additional level-of-effort activities planned for implementation in FY 1977 or beyond. Further, certain existing programs will get more emphasis in FY 1977 and beyond. Some examples of these areas are described below.

- Water Monitoring Methods Equivalency Program: Present regulations allow only dischargers to apply for approval of alternate methods for measuring pollutants in industrial and municipal effluents. Manufacturers of monitoring instruments have no direct recourse for demonstrating the equivalency of their products to the promulgated test procedures. The most reasonable solution to this problem is to set up a program similar to the ambient air equivalency program. This requires promulgation of new regulations or amendments to existing ones.

- Agency-wide Laboratory Automation Systems: Laboratory automation consists of applying small computers (mini-computers) to sophisticated laboratory instruments to control their operation, process their data and generate reports for laboratory scientists. With this technology, it is possible to increase the quality and quantity of laboratory data and provide substantially increased capabilities with no increase in personnel. This advanced technology is of particular importance to monitoring laboratories that must accurately analyze large numbers of samples to support enforcement actions.

- Advanced Monitoring Systems: The task of measuring environmental pollutants is currently labor-intensive. Development and use of less labor-intensive techniques such as advanced remote monitoring instrumentation, mounted on airborne and ground-based mobile platforms with automated data acquisition systems, is an obvious alternative. These techniques have potential for cost-effective monitoring of trends that are needed for development and evaluation of adequate control strategies.

ORD plans to continue to capitalize on monitoring capabilities developed by other organizations. The transfer into and application by EPA of advanced technology developed outside the Agency has been accomplished by pilot projects on real problems. The Regions and other EPA Offices continue to need total monitoring systems because these systems often represent a way of completing pressing tasks in a faster, more cost-effective manner.

Certain monitoring needs can only be addressed with aerial monitoring systems. Some specific objectives and benefits to be derived from the development of advanced monitoring systems are as follows:

Land Monitoring

- Determine status of surface mines and extent of recontouring and revegetation.
- Assess secondary effects downwind from power generating plants on such receptors as vegetation and urban communities.
- Assess environmental impacts of land disposal of municipal and industrial wastes.
- Assess surface and groundwater quality based on land use mapping.

Water Monitoring

- Measure thermal and spectral characteristics of effluents from power and industrial plants and map thermal gradients in receiving waters.
- Assess environmental trends at ocean waste disposal sites and map transport of pollutants.
- Measure organic and inorganic water pollutants for identification of environmental impact from sewage and industrial plant effluents.
- Obtain measurements of different oil types and hazardous material spills to assess environmental impact and provide surveillance during and after clean-up operations.

- Obtain measurement of turbidity and sedimentation by agricultural runnoff.

- Monitor trends in marine environments associated with outer continental shelf oil and gas drilling and processing.

Quality Assurance

Subprogram Description

Environmental data produced by federal, State and local monitoring activities must be accurate, intercomparable and legally defensible. This is the goal of ORD's Quality Assurance (QA) Subprogram. Although ORD does not have responsbility for actual environmental monitoring, it is responsible for developing and implementing a comprehensive agencywide quality assurance program.

Major activities include:

- Statistical validation and standardization of total measurement systems (development of site selection and validation criteria, flow measurements, sample collection and preservation, analyses and data output).

- Development and distribution of standard reference materials.

- Preparation and distribution of quality control guidelines and procedures.

- Evaluation of monitoring activities (evaluation of facilities, equipment, operators, procedures and performance).

- Development of automated laboratory management systems (application of minicomputers to laboratory instruments, data screening, computerized statistical quality control).

- Technical assistance (assistance in carrying out calibrations, split samples, etc.).

- Development and participation in regional quality control workshops, conferences and seminars.

Over one-hundred measurement methods have been promulgated to monitor compliance and enforce environmental standards and regulations. Measurement methods for criteria pollutants associated with ambient air quality standards have been standardized. Measurement methods for New Source Performance Standards (NSPS) for Regulatory Category I have been tested under actual operating conditions. Also, efforts are progressing to standardize measurement methods for other regulated emission sources and to establish performance specifications for in-stack monitors.

Water quality measurement methods are mostly standard analysis methods taken from scientific literature or developed in EPA laboratories. Procedures for calibration and quality assurance are available from the same sources. These methods work well for specific substances in distilled water. At this point, however, only about 20 methods have been validated for complex industrial and municipal effluents.

The measurement methods validation work will continue until all methods promulgated by EPA are validated. This may require deleting from existing regulations those measurement methods that cannot be validated and providing validated alternate methods.

Reference materials are available for 71 methods promulgated since 1973. And a voluntary quality control activity is ongoing in that a participating laboratory requests a sample with a known concentration of pollutant to calibrate or test its procedures. At the present time, however, ORD is not implementing a comprehensive activity of regular audits of government environmental monitoring labs.

FY 1976 Plan

Some representative examples of the types of effort and output planned for FY 1976 are:

- Single laboratory validation of measurement methods for vinyl chloride, sulfate and arsenic in ambient air.
- Standardization of the calibration procedure for water and wastes discharge flow-measurements.

- Standardization of bioassay procedures for the National Pollutant Discharge Elmination System (NPDES).

- Standardization of sample siting criteria for environmental measurements.

- Guidelines for water and wastes sampling and sample preservation.

- Assessment and evaluation of the feasibility of operating a laboratory evaluation program.

- Quality assurance guidelines for stationary and mobile source pollutant emission measurements.

Five-Year Plan

The character of the Quality Assurance Subprogram can also be described as level-of effort. Accordingly, the planned outputs for individual years of the five-year plan are expected to be much the same.

Long-term goals of the Quality Assurance Subprogram are: (a) to provide all reference methods, site-selection and validation criteria, quality control procedures and standard reference materials needed to enforce existing or planned EPA standards and regulations and to gather data on nonregulated pollutants of conern to EPA; (b) to develop and implement a national plan for laboratory evaluation; (c) to conduct regular audits of performance and quality control practicies in EPA monitoring activities; and (d) to provide assistance to all laboratories that need to upgrade their monitoring capabilities.

In FY 1977 and beyond, the QA activities will be expanded to satisfy mandates of the Safe Drinking Water Act. The States will assume primary responsibility for implementing programs to assure safety of public drinking water, but EPA must certify the State's capability to carry out the program and must provide technical guidance, program overview and quality assurance support. The success of water supply programs will depend on reliable monitoring systems and a national QA service for States. Of paramount and immediate concern is development of standardized measurement systems that can be used for routine determinations of traces of toxic materials in potable waters. No less important is development and maintenance of quality control efforts to assure that all data generated are statistically valid and legally defensible.

Efforts also will continue to improve the quality of air monitoring data by developing criteria for proper validation of site-selection for continuous air monitoring stations. Once established, an effort will be made to regularly audit data from these stations. Additional work will involve evaluating data interpretive techniques and environmental indices.

An important aspect of current quality assurance activity is continuous evaluation of performance of federal, State and local monitoring support laboratories. This activity will be expanded and will include provision of assistance and guidance to those laboratories found deficient.

Technical Support

Technical Support/Technical Assistance

In a sense, the entire ORD program may be considered as technical support to EPA. ORD's function is to provide EPA with the scientific basis for environmental regulations, means of monitoring environmental pollution levels and demonstrable pollution control technology. Much of this effort is long-term and focused on response to EPA's anticipated needs. It is ORD policy to assist EPA in its immediate technical needs whenever possible by using the scientific expertise of its research personnel. Costs associated with this effort in the past have been included in the base R&D program, i.e., within the research program planned and implemented by ORD personnel and not shown as discrete, identifiable tasks.

Additionally, ORD has developed capabilities from its R&D activities that are now largely routine "services" for the rest of EPA. ORD continues to provide these services that are difficult or impossible to duplicate in Regional or Program Offices because of their costs, manpower requirements or their EPA-wide nature. An example of this is ORD's aircraft capability for aerial surveillance.

A less well known example is the ORD Environmental Photographic Interpretation Center (EPIC) with its capability to assess pollution problems from sources such as stack plumes, oil spills and other point and nonpoint sources from aerial photographs. ORD also has advanced, sophisticated, scientific research equipment available such as electron microscopes that are used to support agency operating requirements.

Technical support is distinguishable from technical assistance. Technical assistance is a brief effort in response to unscheduled requests for assistance. It includes such things as expert testimony in legal actions and short-term consultant services. As with technical assistance, technical support is generally a response to an unscheduled request and is normally characterized by projects that are short-term compared to the base research program. Technical support is often characterized by a somewhat longer response time. As with technical assistance, it generally requires no original research, but brings existing knowledge to bear on a scientific expertise for some immediate environmental problem. A major distinction arises, however, in instances where existing information is not adequate and short-term engineering studies must be completed to supply missing information.

FY 1976 Plan

A significant fraction of the R,D&D program in the past was devoted to what is now defined as technical support. It is impossible to say precisely how much. The decision this year to begin to identify technical support work itself reflects a determination that ORD will be more responsive to immediate needs of EPA.

Unlike other parts of the ORD program, resource levels and accomplishment objectives cannot be precisely projected for technical support. The expectation is that after the first year of managing the technical support activities, resources required or actually used will be better known and this information will facilitate planning. ORD's overall goal for now and for the five-year planning period is to be as responsive as possible within the constraint of available resource levels to EPA needs for technical support.

Requests for technical support in FY 1976 are expected to include overhead monitoring support for research projects and regional surveillance activities. Some requests will probably be for aerial infrared photo-surveys of industrial and powerplant discharges and land quality evaluation surveys. In addition, a significant fraction of the requests will probably be for laboratory support and analyses of monitoring nonregulated and toxic pollutants.

Five-Year Plan

Technical support to EPA is clearly a service activity. Planning for the type and quantity of service is based on historical data. The level of support that EPA requires is expected to increase. But the nature of the support effort is not likely to change.

Technical Information

Technical Information was recently established as an area to provide centralized planning and control over a variety of activities that were previously distributed across the base ORD program. This is being done to assure that ORD outputs are provided in a form most appropriate to EPA and external users and that those output will greatly help the Nation's pollution abatement effort.

The planning approach views technical information as a total system and optimizes information delivery from researchers (who also need technical information to do research) to the ultimate user. The major activities assigned to this effort include: technology transfer, technical and scientific publications, library control, automatic data processing (ADP) coordination, Freedom of Information Act compliance, environmental forecast modeling and response to inquiries for technical information from inside and outside.

FY 1976 Plan

Principal objectives of the FY 1976 technical information activities are to increase the overall utility and cost-effectiveness of ongoing technical information efforts and to develop a comprehensive technical information strategy that is responsive to needs of both EPA and other users of ORD outputs. Major accomplishments will include:

- Improved documentations of and accessability to technical information from ongoing research projects.

- A significantly increased number of technical and scientific reports and publications specifically tailored for user application.

- Completion of a five-year automatic data processing (ADP) plan to increase research productivity and cost-effectiveness in utilization of ADP resources.

- Characterization of the near- and long-term technical information requirements of both EPA and other users and development of plans to meet such requirements.

- Establishment of a centralized capability to respond to EPA and other requests for technical information.

- Development of Strategic Environmental Assessment System (SEAS) as an operational tool for environmental forecasting and policy analysis. SEAS will be further developed to support impact assessment of energy, environmental and recovery trade-offs and alternatives.

- The technology transfer effort will conduct seminars on land treatment, advanced waste treatment, industrial pollution control, monitoring of industrial wastewater, water treatment processes and analytical weights and measures. Another key seminar will be on the multimedia pollution control for small businesses. In addition, a variety of specialized reports, design manuals and newsletters will be developed and widely distributed. Special emphasis will be given to development of outputs designed to assist State and local governmental policy-makers in investigating available options to solve municipal wastewater treatment problems.

Five-Year Plan

A fully integrated strategy and five year plan for the technical information activity is scheduled for completion in FY 1976. While still incomplete, it is evident that a significant expansion in this area will be required to effectively transfer R&D outputs that are developed over the next five years in response to existing legislative mandates. For example, the work will expand its technical information transfer activities to municipal and industrial pollution control technology monitoring and nonpoint source management as the Federal Water Pollution Control Act (FWPCA) Best Available Technology (BAT) deadline of 1983 approaches.

Implementation of BAT requirements must begin 18 to 24 months before the deadline, so transfer of BAT technology must be completed before 1980. Work on air pollution control technology, solid waste and toxic substance research and energy and water supply will be significantly increased. The peak in technical information activities should occur in FY 1979 and FY 1980.

ENERGY/ENVIRONMENT PROGRAM

Overview

Several approaches have been proposed as part of a plan to meet the Nation's critical energy needs. These approaches include:

- Increased use of coal by burning it directly and use of coal-derived synthetic fuels.
- Use of alternate sources of energy such as waste, solar, geothermal and nuclear.
- More efficient energy extraction and use processes.

Each scenario can significantly affect environmental quality.

Part of EPA's overall mission is to protect the public health and welfare from adverse effects of pollutants discharged by or associated with energy systems. Such protection requires a multimedia approach so that control of one form of pollution does not result in an unacceptable impact on another media.

Because of potentially adverse health and ecological effects of traditional and new technologies for fuel extraction, processing and conversion, EPA has a major responsibility to protect environmental quality and human health. Also, since many technology development and consequent environmental problems are long-term in nature (e.g., many technologies will not be available and in commercial use before early 1985), EPA must now develop the health and technical data base necessary to support future New Source Performance Standards and Ambient Air Quality Standards. This need becomes quite apparent when lead times for developing a health data base and applying control technology are considered.

Several long-term problems are expected for regulatory and enforcement components of EPA. First, the increased reliance on substitute fuels from coal and oil shale (that require cleaning, gasification and other techniques) can generate new pollutants whose effects are not known and must be defined. Another problem is the potentially cumulative, chronic, health and ecological effects of new and emerging energy sources (nuclear, geothermal, solar, etc.). For example, the nuclear fuel cycle creates problems associated with plutonium dispersion in the biosphere and storage for an indefinite period of high-level radioactive wastes.

There are also energy and environment-related problems that are more near-term and must be successfully addressed by EPA. The unavailability of enough domestic oil and increased dependence upon foreign oil supply has encouraged large-scale conversion of oil-fired boilers into coal-fired boilers that burn high sulfur coal. This fuel substitution will likely produce additional particulate sulfur compounds and other combustion residues with environmental consequences. Also, increased use of coal and oil shale will accelerate mining for these fuels in semi-arid Western areas, raising serious questions about problems of mined-lands restoration and affects on ground and surface water.

A coordinated federal program has been undertaken to meet the above goal with the ORD carrying responsibility for managing and integrating efforts of eighteen federal agencies.

For example, in the areas of health and ecological effects and transport and monitoring, EPA coordinates activities of a dozen federal agencies that are doing research and development in related areas. EPA supplements their programs with interagency funding to provide the proper balance in the overall federal energy and environment research and development. ORD uses its laboratories for diversified programs that include everything from pollutant monitoring and health and ecological effects research to pollution control technology development. These efforts are generally complimentary to work in other federal agencies.

The definition of environmental problems and requirements for control of longer-term problems are particularly important because EPA does not have responsibility for energy technology development even though EPA must work with agencies that do (in most instances ERDA). Factors to consider in solving long-term problems include:

- Environmental assessments of new energy extraction, processing and use techniques (e.g., coal gasification, coal liquefaction) to identify new pollutants and determine their potential health, ecological and other socio-economic effects.

- Develop an adequate scientific basis for new environmental standards and regulations.

- Provide guidance on control technology requirements to federal and industry groups involved in developing and applying new technologies.

- Assist in development of control technologies, especially where ORD has special expertise.

The Energy R&D Program is organized into three subprograms: (1) Health and Ecological Effects; (2) Extraction and Processing Technology; and (3) Conservation, Utilization and Technology Assessment. These subprograms and their major outputs are described below.

Health and Ecological Effects/Energy

Subprogram Description

The energy-related processes and effects R&D subprogram is designed to identify all adverse environmental aspects (essential for criteria development and control technology requirements) associated with energy extraction, conversion and use. Major goals include: (1) adequate protection of human health and the human ecosystem and (2) assurance of environmental protection with expanded use of domestic energy supplies.

For the short-term, primary efforts reflect EPA regulatory requirements. A sound technical base must be provided to support establishment of standards and regulations and to assure a strong Agency defense in event of litigation.

In the intermediate term, research is directed to problem identification and assessment. Early knowledge of adverse energy system health and ecological effects are required prior to system implementation to avoid the need for costly retrofit controls. This work leads to setting priorities for later work and where possible, to avoidance of environmental insults.

The long-term research is largely based on a strategy to prevent environmental damage rather than to only regulate it. For that reason, research is undertaken to better understand environmental processes and effects.

Avoidance of all yet-unrecognized hazards is the major ultimate objective.

The energy-related processes and effects research is divided into four closely-related areas: pollutant characterization, measurement and monitoring; environmental transport processes; health effects and ecological effects.

Pollutant Characterization, Measurement and Monitoring

The monitoring effort is designed to provide data on both ambient and energy-impacted air and water quality. The primary objective is to establish baseline air and water quality data in the Western regions for the purpose of supporting EPA standards. Emphasis will be on SOx, NOx, reactive hydrocarbons, toxic substances and visibility. Areas to be monitored include: The Four Corners area; Northern Great Plains; and oil shale areas in Colorado, Wyoming and Utah.

In the area of remote monitoring, projects are designed to demonstrate the effectiveness of overhead remote sensing and photographic techniques to monitoring energy-related activities and effects. Emphasis is on coal mining and oil shale development to obtain data on land-use surface disruption, surface water, vegetation and visibility.

Groundwater monitoring projects are designed to develop requirements for groundwater quality monitoring in areas of coal strip-mining and oil shale extraction and processing. The objective is to identify the pollutant's presence, identify factors contributing to contamination and demonstrate a monitoring strategy.

Solid wastes monitoring projects are designed to analyze ash, sludge, slag and effluent water from energy-related activities for toxic trace elements. Emphasis is on low-level concentrations of toxic wastes and their paths into the environment. Sources include oil and oil shale processing and coal mining and conversion operations. Tasks are also undertaken to develop sampling procedures, monitoring instrumentation and continuous sensors for energy-related water pollutants including toxic elements, phenols, cyanides, nitrates and phosphates.

Near-term objectives include:

- Development of a five-year air, water and land quality baseline in the Western U.S. Within two years, preliminary environmental data will be available on specific sites in the West. This will allow federal and State officials to consider environmental consequences into policy decisions concerning energy developments (e.g., proposed Kaparowitz Plateau power plants in Utah, oil shale areas of Colorado and Wyoming and strip mining and power plant development in Montana, North Dakota, and Arizona).

- Development of ambient air and remote measurement methods and instruments for aerosols associated with various fossil fuel combustion processes (e.g., sulfur oxides, nitrogen oxides and sulfuric acid mist).
- Develop of water measurement methods for fossil fuel-related organic wastes that are potentially carcinogenic (e.g., oil shale waste).
- Development of methods to monitor pollutants in shallow and deep-lying aquifers in the vicinity of coal mining, oil shale and geothermal developments.
- Development of an airborne laser system for rapid broad scale accurate determination of strip-mine slope contours. This parameter is critical for determining potential for land reclamation and has significance for potential strip-mining regulation.

Longer-term Objectives include:

- Development of an integrated air and water quality data base keyed to ongoing and planned energy developments at specific sites. This is to be complimented by a synoptic, overhead survey of land use at those sites.

Environmental Transport Processes

This research is designed to determine the transport, transformations and environmental fate of energy-related pollutants in freshwater, atmospheric terrestrial, marine and estuarine ecosystems.

The atmospheric portion is designed to determine transport and fate of pollutants generated from various energy activities. Technologies to be considered include oil shale, coal combustion, coal extraction and coal gasification and liquefaction. The major emphasis is on determination of chemical and physical processes associated with: (1) conversion of sulfur and nitrogen oxides to sulfates and nitrates, (2) photochemical oxidant transport and, (3) effects on visibility reduction, haze and radiation balance of airborne aerosols generated by energy-related activities.

The freshwater portion focuses on surface and groundwaters. It is designed to trace the environmental pathways and ultimate fate of organic and inorganic pollutants, complex effluents, dissolved and suspended solids and thermal discharges generated by coal and oil shale development and coal gasification and liquefaction. The marine portion of this research is similarly structured, but concentrates on pollutants from such technologies as offshore power generation, petroleum exploration and extraction and construction of deepwater ports.

Near-term objectives include:

- Initiate study of energy-related air pollutant transport and transformation in the Mid-western U.S. over a radius of several hundred miles. The results of such studies will be correlated with ongoing health effects studies.
- Summarize current scientific knowledge and develop empirical methods to predict stationary source plume dispersion in simple and complex terrain with emphasis on transformation, transport and removal of sulfates and nitrates.
- Develop a site-study capability to measure pollutant removal from the atmosphere by dry deposition and wash-out and rain-out in the vicinity of various sources including tall power plant stacks and smelters.
- Determine fresh, surface and groundwater transport mechanisms and pathways of organic and inorganic pollutants, metals and dissolved solids along with suspended solids from increased coal production.

Longer-term objectives include:

- Determine the relationship of environmental parameters such as conditions of exposure, duration of pollutants, water vapor, temperature, wind and sunlight to materials losses.

- Determine atmospheric effects, including visibility reduction and haze and radiation balance, caused by airborne aerosols produced by energy-related activities and develop methods of relating atmospheric visibility reduction to chemical and physical properties of fine particulates.
- Determine mass balance of pollutants in the air envelope of fuel conversion systems such as coal liquefaction and gasification.
- Determine biological, physical and chemical pathways and transfer machanisms of energy-derived pollutants in soils, economic crops and animals.

Health Effects

The health effects research is designed to ascertain and evaluate health implications of energy-producing activities. This includes aspects of energy conservation and processes involving final extraction, conversion, and combustion. There is a need to expand present knowledge of effects of pollutants produced by fossil and waste-fuel combustion and mobile source emissions. Studies involving selected fuels, fuel additives, advanced engine design and emission control systems are necessary to this effort. ORD will include epidemiological, clinical and toxicological studies emphasizing long-term, low-level pollutant exposures to determine potential teratogenic, mutagenic and carcinogenic effects. This research output is essential to the regulatory role of EPA. It provides a basis for deciding on appropriate control levels.

Near-term objectives include:

- Initiate studies to determine the health effects of waterborne pollutants from present and emerging energy processes and production. This includes pollutants such as heavy metals and organic chemicals and emphasizes toxicological, biological, genetic and other biomedical aspects of subchronic and chronic exposures.
- Health effects information will be developed on multi-route exposure from metallic pollutants associated with fossil fuel extraction, combustion and conservation, considering fuel development alternatives.

- **Heavy metals (nickel, mercury, cadmium, lead, manganese, vanadium, arsenic and others) will be studied to ascertain the effect on health following exposure. These metals will be studied both singly and interactively.**

Longer-term Objectives include:

- Characterization of human exposure to pollutants emitted in ambient air as a result of coal conversion and utilization.

- Emphasis on the impact that future energy policy will have on ambient levels of existing criteria pollutants, aerosols and fine particulates. Of special interest are certain aerosol components such as strong acids, sulfates and nitrates that may cause adverse health effects. such an emphasis will assure availability of health effects information necessary for EPA to assess health and environmental implications of future energy policy decisions in a timely fashion.

Ecological Effects

Ecological effects research studies are oriented to specific pollutants and broader energy technology. These studies are designed to determine the total ecosystem effects of energy development activities. The research objectives are designed to determine effects of organic pollutants, inorganic pollutants, thermal discharges, complex effluents, dissolved solids and suspended solids on freshwater, marine waters and terrestrial ecosystems. Near-term energy technologies related to oil shale production, coal extraction, gasification and liquefaction will receive initial emphasis.

Acute and chronic toxicological effects on freshwater organisms will be determined. The marine ecosystem studies will seek to establish background levels of relevant contaminants in marine organisms and habitats. Further marine studies will include the effects of petroleum extraction and conversion operations, construction of deep-water ports and emissions from offshore nuclear facilities, on the marine ecosystem.

The terrestrial effects studies will determine the acute and chronic dose-response relationships from stress of pollutants from coal, and oil shale extraction, conversion and utilization processes. Other projects will determine metabolic and biochemical uptake mechanisms of SOx, NOx, particulates and trace metals by test organisms, both fresh water and marine. Effects of chronic and lethal levels will also be ascertained.

Near-term objectives include:

- Initiate studies to determine the acute and chronic toxicity of heavy metals, complex effluents, dissolved solids, suspended solids and inorganic and organic stress, on freshwater organisms.
- Baseline evaluation of aquatic ecosystems associated with Western coal development and oil shale development.
- An integrated, total media study of over all environmental impacts of strip-mining and power plant development in Colstrip, Montana.
- Initiate studies to determine the acute and chronic toxicity of petroleum products and biocides to marine and estuarine organisms.

Longer-term studies include:

- Evaluation of first phase research results on activities in petroleum hydrocarbon, trace metals, thermal effects and power plant effluents, with regard to physical, chemical and biolcgical data for model development.

Energy Extraction and Processing Technology

Subprogram Description

Overall objectives of this subprogram are to permit a rapid increase in extraction and processing of domestic energy resources and to enable these energy sources to be used effectively in an environmentally compatible manner. The research is divided into two areas: energy resource extraction and fuel processing.

Resource Extraction

Resource Extraction R&D will assess potential environmental problems and control methods for underground and surface coal mining, oil shale extraction and exploration for and recovery of domestic inland and offshore oil and gas. All these extraction processes have the potential to severely damage water and land quality. For that reason, the chief goal of this research is to provide enough data and analysis to ensure that commercial extraction operations can be conducted with adequate land reclamation and minimal damage to water quality and supply.

Wide-scale strip mining of Western coal may result in significant environmental impacts.

CREDIT: EPA/DOCUMERICA - Bill Gillette

Offshore oil and gas efforts will focus on projecting pollutant discharges and assessing control technologies to ensure protection and restoration of ocean shorelines. Problems of Western surface coal and oil shale mining will receive particular attention because of their profound impact on arid lands and the enormous potential of energy reserves in the West. The research will examine problems of revegetating arid mined land in the West. It will also examine the impact on groundwater from disruption of natural drainage contours and aquifers in coal seams. And efforts will also focus on underground coal mining problems such as acid mine drainage and methods to close abandoned mines.

Fuel Processing

Physical and Chemical Coal Cleaning

Physical and chemical coal cleaning involves methods to physically or chemically remove sulfur from coal having a moderate sulfur content (1-2 percent). This allows the coal to be burned in conformity with clean air standards. The objectives of this research are: (a) to develop commercially available coal cleaning processes for organic and inorganic sulfur and ash in medium sulfur coal while, (b) treating coal cleaning wastes to reclaim or dispose of them in an environmentally acceptable manner.

Coal-cleaning research will assess several technologies including several proprietary chemical coal-processes cleaning pilot plants, a two-stage froth-flotation physical cleaning process and advanced low-polluting, dewatering and drying technologies. Coal-cleaning projects now under way as part of EPA's Energy/Environment Program are designed to: (a) assess the environmental impact of these technologies, and (b) promote coal cleaning as appropriate, because these processes are potentially more efficient for pollutant removal than standard coal-washing processes. The Department of the Interior and ERDA are performing related research in this area.

Fluidized Bed Combustion

Optimal fluidized bed combustion (FBC) processes could use coal, coal-derived products and residual oil more efficiently than other technologies and with little environmental harm. As part of the National Fluidized Bed Combustion Program, coordinated by ERDA, EPA will conduct R&D to determine potential environmental problems from alternative designs and use of fluidized bed combustors.

EPA's participation in this interagency program will consist of environmental assessment of future FBC systems by testing pilot-scale facilities and by continuing research using EPA's FBC "mini-pilot" plant.

Fluidized bed combustion research plans for the next few years include:

- Study of the feasibility of adopting the CPU-400 as EPA's environmental test facility to evaluate environmental and performance problems and control methods.
- Initiating work on use of low-sulfur Western coal for industrial boilers.
- Beginning sorbent regeneration studies to minimize solid waste using the FBC facility at ERDA's Argonne National Laboratory and at the EPA's mini-pilot plant.
- Conducting laboratory and bench-scale studies of operating conditions on an existing 50MW utility boiler of a Chemically Active Fluidized Bed (CAFB) process for converting extremely "dirty" residual oils into clean gaseous fuel to minimize pollutant formation.

Projects underway include: (a) assessing the environmental impact of fluidized bed combustion processes for burning coal; (b) developing environmental controls for coal-burning fluidized bed combustion processes; and (c) developing chemically active oil-burning fluidized bed technology.

Synthetic Fuels

EPA's research on synthetic fuels (high and low BTU gasified coal and liquefied coal) has two aspects:

- To determine potential environmental impacts of synthetic fuel processing operations.
- To develop control technology to minimize potential environmental damage.

Environmental control technology R&D must be conducted concurrently with environmental assessments because some synthetic fuel processes--low BTU gasification in particular--are almost ready for commercial demonstration. Development of an appropriate control technology must be accelerated to permit early commercialization and to avoid the diseconomies of forced retrofitting of pollution controls.

For that reason, environmental assessments will focus on characterization of feedstock materials at the same time that studies are conducted on the impact of shale-oil recovery, coal liquefaction and high and low BTU coal gasification. Technology to control air, water and solid waste pollution from conversion processes will proceed concurrently with fuel processing technology R&D being conducted by other agencies. To facilitate its testing procedures, EPA plans to begin work on a small and flexible coal gasifier to develop and evaluate control technology. Finally, ongoing work will be continued on high temperature clean-up of low BTU gasified effluents.

Nuclear Waste

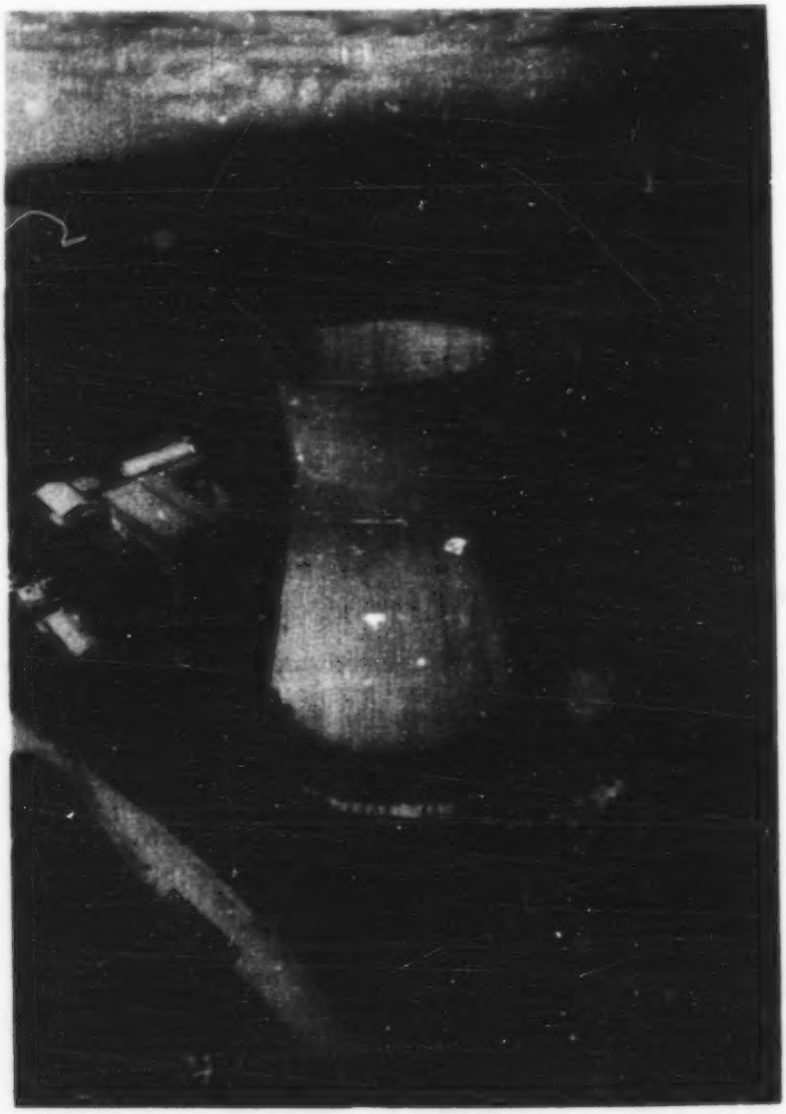
The objective of nuclear waste control research is to evaluate the magnitude of environmental hazards from processing and disposal of nuclear wastes at various stages in the nuclear fuel cycle. Impacts of mining and milling wastes will be the main focal point with EPA devoting most of its efforts in this area to expanding environmental and technological assessment.

FY 1976 Plan

- Publish report on the assessment of high temperature and pressure particulate control methods. Such techniques are necessary for pollution control from second-generation energy systems such as FBC and coal gasification processes.

- An updated report on sulfur reduction potential of U.S. coals will be published. Recent studies indicate that physical coal cleaning and combinations of physical coal cleaning and flue gas desulfurization, may be the most cost-effective strategies to meet emission regulations. Data contained in the updated report will allow selection of the most economical methods to meet air pollution regulations.

- Initiate construction of the Meyers Process test facility for coal cleaning (desulfurization). This process, if successfully scaled-up, would release up to 40% of Appalachian Basin coal for direct combustion in new stationary sources without the need for flue gas desulfurization. The process would be especially appropriate for small utility and industrial and commercial boilers. Data from test facility operation would provide the basis for scale-up to demonstration site.



The ecological effects of thermal discharges from nuclear power plants are being investigated in the Energy/Environment Program.

CREDIT: EPA/DOCUMERICA - Gene Daniels

- A design manual for physical coal cleaning technology will be completed. The manual will make available to plant operators and regulatory agencies the best of existing technology in physical coal cleaning operations.

- Completion of a simple field method to analyze overburden pollution potential prior to mining.

- Completion of the evaluation of long-term effectiveness of reclamation practices.

Five-Year Plan

Outputs of the extraction R&D will define environmental problems associated with surface and underground coal mining in the Eastern and Western United States. Problems associated with active and abandoned mines such as mine drainage, groundwater pollution and reclamation will be considered. Also, methods, techniques and processes for control will be developed. Information similar to that developed for coal will also be developed for oil shale and tar-sands.

The prevention and control of oil spills will receive increased emphasis in later years. So will the determination of environmental impacts associated with offshore gas and oil exploration and development, liquefied natural gas (LNG) and liquid petroleum gas (LPG).

To promote greater use of coal, many processes are under development to obtain a clean fuel from coal. Anticipating these developments, major emphases in the early part of the EPA R&D program will be on obtaining environmental data to define potential problems associated with many synthetic fuel technologies being considered for development (e.g. high and low BTU gasification, coal liquefaction). Other technologies that are being developed and may allow coal and oil to be used with minimum environmental degradation, include fluidized bed combustion (FBC), advanced oil processing; chemically active fluidized bed combustion (CFB) and physical and chemical coal cleaning.

As the data defining environmental impacts and control capability are obtained, emphasis of the problem should change from environmental assessment to control technology development. For that reason, increased funding is allowed for control-technology development for synthetic fuels, fluidized bed combustion, and physical and chemical coal cleaning.

Since EPA does not have sole responsibility for developing the technologies that can allow greater use of coal, the EPA control technology program will continue to be coordinated with other agencies such as ERDA and DOI and resources will be set aside for interagency agreements.

Additional milestones to be achieved in the FY 1977 - FY 1980 period include:

- Completion of environmental testing of operating Eastern and Mid-western coal cleaning plants to support setting of standards for new plants.
- Identification (lab scale) of novel technologies to remove sulfur, nitrogen and hazardous trace materials from coal and coal cleaning wastes.
- Testing and demonstrating deep physical coal cleaning of utility coal and burning it afterwards in a way that meet State and new source performance standards.
- Operation of the joint EPA/U.S. Bureau of Mines physical coal cleaning test facility.
- Completion of environmental testing of the ERDA 30 MW atmospheric FBC facility and preparation of a manual of practice in support of setting NSPS.
- Operation of an Exxon miniplant in support of the ERDA pressurized FBC program and EPA environmental assessment program.
- Completion of the development of pollutant sorbent regeneration and alternate sorbents for FBC systems.
- Completion of the development of high temperature and high pressure granular-bed-filter fine particulate control technology for support of NSPS for pressurized FBC and gasification processes.
- Demonstration of energy and environmental benefits of the CAFB process for residual oil gasification/cleanup at a utility boiler.

- Completion of bench-scale development of oil desulfurization, denitrification and demetallization technologies.

- Completion of environmental testing and development of manuals for control technology practice in support of standards for coal gasification, coal liquefaction, residual oil cleanup and oil shale processing.

- Completion of the EPA/ERDA pilot demonstration of a high-temperature sulfur removal system for coal gasification.

- Development of manuals for control technology practice to support effluent guidelines for acid mine drainage, sediment runoff and other discharges from Eastern coal mining and handling.

- Completion of assessment of pollution potential of coal and oil shale mining in the Western U.S. and coal mining in Alaska.

- Completion of assessment of environmental problems in uranium mining and beneficiation, nuclear fuel transportation and nuclear waste disposal and reprocessing operations.

- Completion of a demonstration of technology and development of manuals for clean-up of oil spills on land and water.

- Preparation of manuals of practice for protection and restoration of ocean, estuarine river and cool-climate shorelines because of oil contamination.

- Completion of manuals of control technology practice to support effluent guidelines for offshore oil and gas production facilities.

Energy Conservation, Utilization and Technology Assessments

Subprogram Description

This program includes the following:

- Utility and Industrial Power Technology

- Energy Conservation
- Integrated Assessment

Emphasis is focused on identification, characterization, assessment and development of control technology for pollutants associated with utility and industrial combustion sources. Attention will be given to generating information that can be used to help set environmental standards and guidelines and develop cost-effective control technology to achieve such standards.

The second aspect, energy conservation, calls for an assessment of potential environmental effects of advanced power systems and industrial process changes to achieve energy conservation. The third aspect, integrated assessment, will evaluate comprehensive environmental protection standards for energy production activities while attempting to balance environmental and economic costs.

Utility and Industrial Power

Flue Gas Desulfurization

Cleaning of flue gases from coal-fired utility and industrial boilers has highest priority in federal environmental pollution control technology R&D program for several reasons. First, flue gas desulfurization (FGD) processes in particular are important in terms of national energy self-sufficiency. The only way to significantly increase near-term coal use without severe environmental disruption is to have air pollution control technology available to meet Clean Air Act requirements. Because coal conversion (gasification and liquefaction) processes seem promising but will not be ready for commercial application for quite some time, successful flue gas desulfurization R&D will provide the only viable coal-combustion control technique available in the 1970's. This will have greatest significance in regions that now rely less on oil and gas and more on coal, especially high sulfur coal for generating electrical power.

Second, FGD systems, many in commercial operation or on order, are in final stages of development. R&D efforts will focus on remaining problems such as upgrading operating performance and reliability, minimizing costs, waste product disposal problems and treatment and by-product recovery. This should allow FGD technology to be more generally used in some regions. Funding for this work was expanded in FY 1975 to include capital for two advanced stack-gas cleaning demonstrations. Funding levels will decrease in FY 1976 and subsequent years since no further full-scale utility demonstrations are scheduled.

In addition to R&D on advanced scrubber systems and waste disposal techniques, flue gas cleaning (FGC) efforts will contribute to characterization of fine particulates, hazardous pollutants such as trace materials from coal combustion and metallic acid sulfates.

NOx Control Technology

This R&D will identify, assess and promote development of cost-effective, commercially viable methods for control of oxides of nitrogen (NOx) from both existing and new stationary combustion sources. NOx emissions have been large in amount and could have widespread, adverse health and ecological effects. EPA's Maximum Stationary Source Technology (MSST) strategy places increased emphasis on controlling emissions from stationary sources. Because of the lack of such control technology, this R&D is designed to increase the degree and effectiveness of NOx control from stationary sources.

EPA's overall program for control of stationary source NOx emissions relies primarily on development and demonstration of Combustion Modifications (CM) processes for utility, industrial, commercial and residential boilers. These processes minimize formation of nitrogen in the combustion zone. Such control measures should not reduce efficiency of combustion heat recovery nor increase emissions of other pollutants.

An alternative approach that is being explored is "flue gas cleaning" involving flue gas treatment.

Particulate Control

Fine-particulate control technology to meet present and future emission reduction requirements is being developed by EPA. The emphasis of the fine particulate control R&D is on controlling emissions from direct combustion of low-sulfur or cleaned coals. Although particulate control technology has been used on combustion gases from high-sulfur content coals, low-sulfur content coal use presents a different problem.

In electrostatic precipitators--the most common control method used in utility boilers--lower sulfur content flue gas can degrade electrical properties of the precipitator and consequently, its performance. Injection of sulfur trioxide to improve electrical properties aggravates the secondary sulfate emission problem.

The fine particulate control R&D includes efforts to: (1) improve precipitator performance on low sulfur coals and (2) develop other devices for conventional and advanced coal use.

Potential health effects of metallic acid sulfates, trace materials and other fine particulates, may limit coal use in the future unless control processes are understood and technology developed to meet emissions standards. Cooperative efforts with EPA, ERDA and TVA, are underway to fully characterize particulate emissions from conventional and advanced coal combustion systems.

Thermal Control

Power plants discharge large amounts of heat into receiving water. Even if energy demand decreases somewhat in the next few years, construction of new coal-fired and nuclear electrical power plants will magnify the problem of how to dispose of waste heat with little environmental damage.

Under the Federal Water Pollution Act of 1972, EPA is required to regulate thermal effluents. EPA's research for FY 1975 and FY 1976 is a response to its own statutory requirements. Objectives of the thermal control area include:

- Providing design and performance data for improved cooling systems.
- Reducing the dependence on use of rivers and lakes as heat sinks.
- Assessing the potential for waste heat reuse in agriculture greenhouses, aquaculture and cyclical storage.

FY 1976 tasks that will be under way include: (a) advanced waste heat control using cooling towers; and (b) advanced waste heat control through waste heat and water use.

Conservation

Improved efficiency in fuel use is a potentially attractive way to help achieve energy self-sufficiency. But work is needed to assess potential environmental impacts of improved or advanced energy systems. Research efforts will concentrate in four areas:

- Industrial Processes: Energy-saving industrial process changes resulting from increased energy costs or governmental regulations or incentives may produce unanticipated pollutant emissions. Accompanying environmental assessment work is needed in this area. And environmental R&D on energy-saving industrial processes will expand in the next few years.

- Advanced Power Cycles: Work on advanced power cycles such as gas turbines, magnetohydrodynamics and fuel cells must be accompanied by identification, measurement and analysis of health and ecological effects of pollutants emitted.

- Energy from Wastes:: Several methods of using waste materials as energy sources have been investigated. It is now technically and economically feasible to use municipal solid waste (MSW) as a fuel substitute in coal-fired power plants. As a result, this R&D has new projects that include: (1) co-firing MSW with coal in a smaller (stoker) boiler and (2) co-firing MSW with residual oil. If successful, these two projects will demonstrate that energy recovery from MSW is feasible throughout the country for smaller cities. Pollutant characterization studies are also being made to ensure that potential environmental problems are defined.

  An alternative to direct combustion of MSW is conversion to synthetic gases, liquids, and solid fuels. Pyrolysis of MSW is now being demonstrated in Baltimore (Monsanto Process) and San Diego County, California (Garrett Process).

- Advanced Energy Systems: In keeping with its general philosophy of anticipatory R&D for energy systems that will be developed over the long-term, EPA has begun assessment studies to provide baseline information about potential environmental impacts of geothermal and solar energy systems.

Integrated Assessment

Environmental, economic and social consequences of energy alternatives together must be used as a basis for EPA policies. Projects are designed across entire technologies and fuel cycles to multi-faceted effects on natural and human-modified environments of energy development and related activities. The alternatives for controlling environmental pollution associated with those activities are also examined. Studies will focus on environmental, economic, social and institutional impacts of various technologies under alternative environmental management approaches.

FY 1976 Plan

- Complete the FGC evaluation phase of Louisville Gas and Electric test program. The objective is to understand and apply the unique chemistry of this successful installation to other installations.

- Complete the pilot and prototype double-alkali FGD test program and publish a final report. This process has potential cost, reliability and sludge disposal advantages over lime and limestone scrubbing systems.

- Initiate a Wellman-Lord regenerable FGD test program at coal-fired utility sites. This process has been proven reliable and effective on oil-fired units in Japan and will now be demonstrated on this full-scale unit.

- Issue a final report on sludge conversion (regeneration) pilot studies. Successful technology development would help solve FGD sludge-disposal problems by allowing conversion and reuse of sludge as an alternative to disposal.

- Document application of staged combustion NOx control technology for tangentially coal-fired utility boilers.

- Issue an annual report on assessment of Japanese flue gas treatment technology for NOx control. Such technology, capable of high efficiency NOx removal, is advancing rapidly in Japan and is being applied to several large installations.

- Complete the fine particulate charge droplet scrubber demonstration. Such technology has potential for enhanced fine particulate removal from a variety of combustion and industrial sources.

Five-Year Plan

Emphasis in the early part of the five-year plan is on obtaining the outputs from the flue gas desulfurization (FGD) work. Data from test programs for nonregenerable FGD systems are expected to indicate improved reliability and lower costs. In addition, test programs for regenerable FGD systems will provide data for evaluation as will supporting studies involving by-product marketing and wastewater utilization from FGD systems. These efforts should be near completion in FY 1977. All data generated from the FGD R&D is expected to be given to regulatory groups and user industries through the technology transfer program.

As the FGD R&D peaks and tails off, emphasis and resources of the energy program will shift to NOx control, fine particulate control, thermal control and combustion pollution assessment.

The NOx control program will include field testing and characterization studies and development of control technology for gas turbines and utility, industrial and commercial boilers. NOx control for residential heating systems will also be considered. Simultaneous removal of SOx/NOx by way of FGD technology will also receive attention.

The fine particulate control program will also accelerate as effort is made to determine the effectiveness of available control equipment, to improve existing control equipment capability and to demonstrate the efficiency of novel devices.

The expectation is that environmental assessment of conventional combustion systems will allow for an informed, orderly identification and ranking of pollutants and their potential impact according to pollutant media (e.g. air, water, solid waste). This approach will guide EPA and its R&D program in determining adequacy or inadequacy of existing and planned programs.

The effort for thermal pollution control work will also increase. Studies to optimize dry cooling systems, for site-specific wet and dry cooling systems relative to fog control and water conservation and for waste heat utilization, will also be in progress.

Conservation studies and demonstrations should continue at a relatively constant rate. Demonstrations of use of wastes as fuel, assessment of advanced cycles, assessment of advanced energy systems and industrial conservation are expected to provide data on potential environmental impacts of those technologies to guide R&D program planning.

Additional milestones to be achieved in the five-year plan include:

- Complete the Shawnee/RTP advanced lime and limestone test study and publish a final report. This test activity is aimed at identifying improved process alterations capable of improving sulfur dioxide removal, economics, reliability and sludge characteristics.
- Complete the Shawnee sludge demonstration evaluation program. This involves a pilot test of three commercially offered sludge-fixation processes and follow-up environmental evaluations.
- Complete the Bahco test study for lime scrubbing on a coal-fired industrial boiler and publish a final report. This will evaluate a sulfur control option for smaller combustion sources.
- Complete a final report on the Wellman-Lord FGD demonstration. This report will summarize operational performance of the first application of this FGD technology to a coal-fired power plant. Sulfur will be produced as the end product.
- Issue a final report on Louisville Gas and Electric lab and field FGD waste-disposal studies. The objective here is to: (1) understand and apply the unique chemistry of this successful unit to other applications and (2) improve sludge-disposal technology.
- Prepare annual reports summarizing the EPA-sponsored FGD sludge effort encompassing evaluation studies and pilot and prototype-scale testing.
- Complete preliminary studies assessing the impact of gas, water and waste streams from a variety of combustion sources.

- Perform a comprehensive application testing activity aimed at identifying means to control NOx through operational modifications for a wide variety of combustion sources.

- Develop and apply NOx control technology employing modifications to utility, commercial and industrial boilers, residential heating systems, stationary engines and advanced combustion processes.

- Develop promising flue gas cleaning methods for NOx control at the small pilot level. Such systems offer potential for enhanced NOx emission control from a variety of combustion sources.

- Enhance the effectiveness of conventional particulate control devices for fine particulate removal including electrostatic precipitators, baghouses and scrubbers.

- Select, test and evaluate one promising, novel fine particulate control device at the pilot level.

- Demonstrate wet-and-dry and dry cooling tower technology capable of dissipating waste heat from steam-electric plants at the prototype level while minimizing water pollution and water supply problems associated with wet cooling towers.

- Conduct feasibility studies aimed at evaluating use of waste heat for agricultural and aquacultural purposes.

- Perform economic, technical and environmental evaluations of resource recovery systems and refuse-derived fuel-processing and energy-recovery equipment and systems.

- Identify and characterize various waste streams and perform emissions and residuals studies on pollutants already in wastes or produced in resource recovery and energy conversion processes.

- Develop pollution control techniques for waste reuse processes.

- Complete development of the "St. Louis" system for combined firing of refuse and coal in a large utility boiler.

- Develop systems for co-firing wastes and coal in industrial-sized boilers and for co-firing wastes and oil in large utility boilers.

- Assess the air quality inside various types of buildings in relation to energy conservation approaches and outdoor air quality.

- Evaluate the potential environmental impacts of the following advanced cycles: high-temperature open- and closed-cycle gas turbines; MHD; potassium topping cycles and thermionics.

- Conduct environmental assessment studies and evaluate environmental control technology needs for geothermal and solar energy systems.

- Perform studies to evaluate the cost, risk and benefit trade-offs of energy production, conservation and pollution control alternatives.

- Conduct technology assessments that evaluate alternative energy technologies and approaches to implement energy development and conservation to prevent environmental damage and secure related benefits.

APPENDIX A

Environmental R&D in Other Federal Agencies

The Environmental Protection Agency (EPA) is but one of many agencies with environmental research and development (R&D) programs. Environmental R&D is defined by EPA as R&D that concerns itself with some aspect of environmental pollution. This could include emissions, transport processes and fate, impacts or effects and control technologies and management methods for pollutants. Such research covers air and water pollution, pesticides, solid waste, water supply, noise, radiation and toxic and hazardous substances.

The National Environmental Policy Act (NEPA) required federal agencies to consider environmental consequences of their actions. Such a demand led to an increase in environmental R&D in many areas. While EPA is clearly mandated to be the lead Agency in environmental R&D, the missions of other federal agencies necessitate environmental R&D. Therefore, EPA has the responsibility to make sure that environmental R&D capabilities in other agencies are not unnecessarily duplicated but are recognized and utilized as efficiently as possible.

The largest and most formalized example of EPA-coordinated interagency R&D is in the energy program where EPA has the responsibility of administering a five-year $100 million plus-per-year program with 18 other federal agencies. Under this program, about 40 percent of EPA's energy budget is given to other federal agencies under formal interagency agreements that produce research and development in all aspects of energy and environmental interactions.

The remainder of this appendix tells what each federal agency with a sizable environmental R&D program does. It gives: (1) a brief description of that program; (2) estimated FY 1976 budget; and (3) examples of relationships with EPA/ORD.

Much of the following information on program descriptions and FY 1976 budgets has been extracted from: "Report on Federal R&D Program FY 1976," by the Federal Council for Science and Technology. This report analyzes environmental R&D in a broad range of federal activities. It includes earth resources, monitoring, mapping and surveying, land-use planning and land management, oceans and climate and atmospheric research. This is in addition to the more commonly defined "environmental" categories of ecology, pollution control and abatement and environmental health. Obviously, all of these areas are closely related and often overlap. For this reason, environmental R&D will be viewed in a broad sense in this section.

Summarized below are the other major FY 1976 federal R&D programs related to environmental understanding, protection and health. In addition to the Agency-specific cooperative research, EPA/ORD often participates informally in various interagency scientific and technical committees, panels and task forces.

Department of Commerce

The National Oceanic and Atmospheric Administration (NOAA) has planned $87 million in environmental R&D in FY 1976. This includes:

- Great Lakes research,
- Marine ecosystems analysis and ocean dumping problems,
- Effects of marine environmental alternatives, i.e., deep water ports,
- Fisheries ecological investigations,
- Environmental impact analysis.

To assure coordination of efforts, ORD participates with NOAA on the Great Lakes Basin Commission, Interagency Commission on Marine Science and Engineering and International Association for Great Lakes Research.

ORD personnel, along with representatives from NOAA, Fish and Wildlife Service, Energy Research and Development Administration and others, meet regularly in the Interagency Coordinating Committee on Contaminants in Aquatic Organisms and the Aquatic Environment to share information. ORD also works with NOAA in the Regional Air Pollution Study (RAPS) in St. Louis.

In FY 1976, EPA will transfer $3 million to NOAA to study effects of petroleum hydrocarbons on marine and estuarine ecosystems in the Gulf of Mexico and Northern Puget Sound. NOAA will also make atmospheric and meteorological measurements and analyses of power plant generated pollutants in the Western United States.

The National Bureau of Standards (NBS) conducts almost $3 million in environmental R&D related to:

- Improving air quality measurement techniques useful in enforcement of air quality standards.
- Improving techniques for measuring low-level or trace pollutants, including radioactive substances, in water.
- Development of standard methods for measuring noise levels, including techniques for calibrating monitoring equipment.

In FY 1976, EPA will transfer $1 million to NBS to develop energy-related water pollutant analysis instrumentation for the purpose of detection of hydrocarbons from power plants and effluents from coal gasification and liquefaction plants and oil shale and petroleum operations. NBS will also develop standard reference materials for energy-related pollutants in the atmosphere, freshwater and estuarine ecosystems.

National Aeronautics and Space Administration (NASA)

NASA has approximately $132 million for environmental R&D in FY 1976. The major environmental effort of NASA is the Earth Resources Technology Satellite program (LANDSAT). LANDSAT applies space technology to data-gathering about earth's resources to improve resource management. More specifically, the following efforts are under way:

- Applications Airborne Research Program that includes analysis of environmental quality.
- Climatic research that will improve atmospheric measurements, remote-sensing capability related to the earth's radiation balance and atmospheric pollutants and climatic modeling.
- Several ongoing and planned nimbus flight projects for all-weather atmospheric sounding, pollution monitoring and climate and ocean research.

In addition to some joint EPA/NASA remote-sensing interests, EPA/ORD works with NASA on the International Joint Commission in the Great Lakes. EPA will also transfer $500 thousand to NASA in FY 1976 for overhead monitoring support to 50 sites associated with Western energy resource development.

Department of the Interior (DOI)

The DOI will spend about $160 million in FY 1976 for R&D directly and tangentially related to environmental understanding and improvement. This R&D includes:

- Environmental studies in support of energy R&D, i.e., siting, operation and waste disposal for nuclear power plants; abatement of pollution from metallurgical processes and wastes; petroleum development of the Outer Continental Shelf; and application of environmental resources data to urban decision-making.
- Baseline hydrologic data will also be collected to provide the basis for continued monitoring of environmental impacts on water resources systems and use efficiencies.
- Environmental observations and measurements by the Geological Survey related to quality and quantity of water supplies.
- Research in irrigation management, wastewater reclamation and reuse and development of predictive models for salinity and nitrogen.
- Conducting mining research to maximize mining production with minimum pollution and damage to the environment.
- Conduct research with the Fish and Wildlife Service (FWS) on effects and residues of pesticides in animals.

EPA will transfer $3 million to DOI in FY 1976 to study the effects of energy resource development on wildlife and wildlife habitats and to monitor both surface and groundwater quality next to Western energy development sites.

To make use of more coal with minimum environmental degradation, EPA through interagency agreements, is working with the DOI in studying physical and chemical coal cleaning. Specific subjects of interest include: (1) improving or developing techniques for mechanical dewatering of fine-size coal, (2) evaluating new concepts for chemical coal cleaning, (3) R&D to eliminate coal refuse ponds and (4) coal washing demonstrations. EPA funding of coal cleaning projects through interagency agreements with the DOI in FY 1976 will be about $930 thousand.

In addition to these cooperative energy and environmental studies, EPA/ORD has an interagency agreement with the Geological Survey on research of methods to estimate "natural" water quality in streams. EPA/ORD also participates with DOI on the International Joint Commission on the Great Lakes in a study to test validity of indexes for water quality and to select a standard array of reporting methods. EPA/ORD also participates with the FWS on various studies on pesticide effects.

Department of Agriculture (USDA)

The Department of Agriculture will conduct about $120 million of environmental R&D in FY 1976. The research is directed at maintaining stable and productive agriculture through soil, water and crop management practices that reduce: soil erosion and water runoff, wind erosion losses from agricultural lands and soil salinity. Research to make efficient use of irrigation water and improve soil drainage is also included.

Other research is conducted on control of pollution from animal and agricultural processing wastes, including possible pesticide contamination. Large programs are conducted on insect, plant disease and weed control employing integrated pest management practices and conventional pesticide use.

Still other research is directed to development of economical farming and land use practices that prevent environmental contaminiation by fertilizers, pesticides, agricultural and municipal wastes and sediments; ensure long-term availability of land for maximum production of food and fiber, water supplies and recreation; reclaim mined lands; protect soil against erosion; and conserve fertilizer and energy supplies.

In addition, research by the Economic Research Service (ERS) focuses on the impact on food and fiber supplies and prices of alternative environmental quality standards or restrictions. The costs of new technology and management practices related to agricultural production are also being assessed.

ORD cooperates with the USDA in the following areas:

- Salinity reduction programs in the Colorado River Basin, Rio Grande River Basin and sediment reduction programs in the Northwest.

- Investigations of environmental consequences of alternative silvicultural practices, including cost-effectivenss of alternate control practices (with U.S. Forest Service).

- Research involving land application of municipal wastewater and sludges.

- Principles, strategies and tactics for pest population regulation and control in major crop ecosystems.

- Studies on pasture and rangeland runoff.

- Research on runoff from land application of animal wastes and development of control methods.

- Research involving uses and reuse of animal wastes other than as fertilizers.

- Research on effects of air pollutants on crops.

- Development of a predictive model for runnoff of pesticides and nutrients from croplands.

- Development of regional reports on current land and water use and agricultural economic implications for future resource use, resource competition and environmental quality from various levels of coal and oil shale development.

- Determination of the impact of energy development in the Northern Great Plains on employment, income, population and local government finances and services.

- Evaluation of reclamation costs and alternative technologies and uses for reclaimed land on selected sites.

- Development of analytical systems to evaluate inter-regional economic implications and trade-offs for agricultural and rural areas produced by coal development.

- Development of plant species and lagoons for revegetation of Western energy-resource areas.

In FY 1976, EPA's Energy/Environment Program will transfer $1.3 million to the USDA.

Energy Research and Development Administration (ERDA)

ERDA will incorporate environmentally-related R&D programs from the former Atomic Energy Commission and the Department of the Interior into its program for FY 1976. In the area of environmental and safety research, ERDA is requesting $178 million in FY 1976. Continued emphasis will be given to studies in the biomedical and environmental sciences on effects of energy production on living systems to assess, control and envaluate the effects of exposures to man and his environment. Specific activities include increases in such priority areas as:

- Biomedical and environmental effects of transuranic isotopes.
- Biological effects of low doses of radiation.
- Thermal effects.
- Offshore siting.
- Evaluations of the impact of nuclear and other energy-producing systems on a regional, national, or other geographical scale.
- Health and environmental consequences of pollutants from non-nuclear energy sources, especially fossil fuels.

Research and development will also be strengthened on transportation and long-term management of radioactive materials and wastes from chemical and ERDA operations.

Much of the other R&D of ERDA now separately defined as "Environmental and Safety R&D" is also environmentally-related. This is particularly true of fossil fuel and electric power transmission R&D to provide energy with fuels and processes that meet environmental quality standards. Such R&D includes impact measurement and evaluation, collection of data on effluents from facilities using new conversion processes and work on new environmental control technologies.

Research motivated by environmental concerns draws on the physical research program for knowledge of radiation chemistry and photochemistry of pollutants and aerosol formation and pollutant effects on the upper atmosphere; tritium and other radioactive waste removal; and better techniques for analysis of pollutants, especially those produced in energy processes.

EPA is currently supporting research through interagency agreements with ERDA in serveral areas.

In the physical and chemical coal cleaning area, work is under way to characterize trace elements in coal cleaning wastes and to evaluate at laboratory scale new physical and chemical processes to remove and recovery trace elements.

In the fluidized bed combustion (FBC) area, work is under way at bench and laboratory scale to determine: (1) techniques for reduction of nitrogen oxide emissions, (2) sorbent performance for control of sulfur dioxide emissions, and (3) the fate and control of trace element emissions. Other efforts in the FBC area include modeling of sulfur dioxide capture rates, characterization of particulate emissions, techniques for reduction of nitrogen oxide emissions and combustion studies comparing limestone to dolomite over a broad range of temperatures, coals and particle sizes.

EPA is also involved with ERDA in technologies to develop synthetic fuel from coal. Specifically, test programs of processes supported by ERDA are of interest in that process and effluent streams can be identified and monitored and analytical methods developed. The effectiveness of control technology from operating data will also be evaluated.

EPA will get data through ERDA for cost, risk and benefit tradeoff analysis of nuclear, oil, shale, geothermal and coal use for power production in the Western United States.

EPA funding of these projects with ERDA in FY 1976 will be about $2 million.

In FY 1976, EPA will transfer $5 million to ERDA to study the fate and effects of petroleum hydrocarbons in Arctic ecosystems, Lake Michigan and coastal areas of Puerto Rico. ERDA will also do terrestrial ecosystem impact studies for the Four Corners Region and parts of the

Southeastern U.S. Improved instrumentation and methods to measure and analyze air pollutants produced by energy developments will also be studied.

EPA/ORD participates on various advisory boards and panels of the Nevada Operations Office. ORD also provides support to ERDA through an interagency agreement in the Regional Air Pollution Study (RAPS) in St. Louis.

Nuclear Regulatory Commission (NRC)

NRC has responsibility for reactor safety research ($72 million), nonreactor confirmatory research ($8 million) and safeguards research on physical protection and materials control and accountability ($7 million). Of these, the most environmentally-related is the nonreactor confirmatory research program that includes four main concerns: (1) health and environmental impact for licensed nuclear facilities; (2) fuel-cycle safety assessment research, (3) waste management, and (4) transportation.

The health and environmental impact research includes projects related to:

- Defining the biological and ecological effects of radioactive, chemical and thermal discharges.
- Development of environmental pathway and related predictive models.
- Dose conversions and measurements.
- Development of cost and benefit and social-value assessment methodologies.

Fuel-cycle safety assessment attempts to verify from actual operating experience the predicted performance of nonreactor plant processes and effluent control systems. This is done to provide more precise estimates of plant performance and environmental impacts for licensing and standard-setting activities.

Waste management research supports NRC's responsibility in licensing nuclear facilities to assure that radioactive wastes remain nonhazardous. The research is directed at analysis of costs, risks and benefits of various waste management techniques and development of data necessary to establish licensing requirements for waste storage.

Research on transportation of radioactive materials develops methodology for reviewing proposed transportation systems, predicting performance and verifying relationships between tests and actual transport conditions. Research supports establishment of transport standards for new types of materials. Studies are also made of characterizations of radiation exposures and accident probabilitites and consequences.

Department of Defense (DOD)

A primary objective of the $56 million R&D program of the Department of Defense in environmental sciences (atmospheric, oceanographic and terrestrial) is to provide the basic technology to enable DOD to "tailor" environmental information to system designers, developers and operators. In addition to addressing operator-identified requirements for better environmental information, the R&D program attempts to assist designers in developing tomorrow's weapon systems so that all immediate environmental factors and total environmental impact can be accommodated at each stage of system design and development. DOD also conducts research on the application and disposal of pesticides.

Important to EPA is the Corps of Engineers R&D program concerned with determining effects of engineering projects on the environment. Investigations are conducted on coastal processes and ecosystems, flood control, hydrology of cold regions, water resources planning and management, wastewater management and environmental quality and impact assessment.

EPA/ORD has a commitment to the States to conduct a National Eutrophication Survey in cooperation with DOD. Also, ORD participates with the U.S. Army Corps of Engineers in the International Joint Commission on the Great Lakes and on a committee to coordinate dredge-material ecological research activities.

National Science Foundation (NSF)

The NSF conducts environmentally-related R&D programs related to climate, oceans and arctic resources and basic research related to specific, current problems under the Research Applied to National Needs (RANN) program. These programs will total in excess of $120 million in FY 1976.

The Arctic Offshore Resources Program ($2 million) is a multidisciplinary, international effort to develop an understanding of arctic environmental factors important to the solution of problems identified with offshore resource development and transportation.

The International Decade of Ocean Exploration (IDOE) is a major program that includes investigations and experiments to provide the scientific basis for improved oceanographic and atmospheric forecasts. Another $5 million under the IDOE will be concerned with environmental quality, with studies of the marine environment, the effects of pollutants on that environment and the scientific basis for marine preservation policies.

Other NSF national and international programs that are in part environmentally-related include some basic and applied environmental research under the Special Foreign Currency Program and International Cooperative Science Activities. NSF also supports basic atmospheric and other research of National Center for Atmospheric Research (NCAR).

In the biological sciences, there is a special focus on properties and interrelationships of natural ecosystems. Such studies provide the basis for development of predictive models showing the effects of varying land use and environmental changes. Basic research related to ecosystems in lakes and ponds has been used by various federal agencies in applied programs related to eutrophication and other effects of pollution problems. Similarly, basic research on terrestrial ecosystems has been applied in research related to forest management, crop ecosystems, energy development, etc.

Fundamental engineering research relating to the environment includes that concerning erosion, groundwater contamination, mining and excavating, wind effects on pollution transport and structures and engineering considerations associated with natural disasters.

Basic research in the environmental sciences (atmospheric sciences, earth sciences and oceanography) includes approximately $5.7 million for pollution problems.

In the RANN program, environmental research is of major importance. The program level for FY 1976 is about $27 million. The RANN program effort is closely coordinated with other federal agencies to ensure complimentary and the early use of results.

RANN's environmental program emphasizes environmental effects of energy ($1.5 million), trace contaminants ($5.8 million), regional environmental systems ($6.7 million), weather modification, and disasters and natural hazards ($13.2 million). A wide variety of research is conducted in these general areas. Additional research relates to regional ecology; land use planning and management; regional environmental management; coastal engineering and coastal zone management and environmental modeling, environmental data and policy and cost-benefit studies; solid waste management and disposal water quality and waster use; wastewater treatment; thermal pollution; air quality and air pollution control; content and variability of atmospheric gases; transport, fate and effects of trace contaminants; and effects of energy, industrial processes and agricultural chemicals and wastes.

RANN's fossil-energy program of $3.8 million includes research related to environmental impacts of coal conversion, gas liquefaction and tertiary oil recovery.

EPA/ORD has numerous working agreements with the NSF. Among these are: evaluation of costs and effects of alternative patterns of metropolitan development; and study on principles, strategies and tactics of pest population regulation and control in major crop ecosystems. ORD also coordinates work on sulfates and organics with NSF.

Department of Health, Education, and Welfare (DHEW)

The concern of DHEW is with effects of the environment on man rather than environmental effects *per se*. Research in environmental health is directed at identifying potentially harmful environmental agents, assessment of their effects, understanding of their mechanisms of actions and methods to ameliorate resulting hazards. Such research gives the health basis for federal regulatory agencies to evaluate impact of alternative environmental control options. DHEW research also gives health-oriented agencies and personnel the basis for efforts to mitigate or prevent diseases with environmental origins.

Research is conducted through the National Cancer Institute ($69.6 million), the National Institute of Environmental Health Sciences ($31.1 million), the National Institute of Occupational Safety and Health ($2.5 million) and the Food and Drug Adminstration ($46 million).

Research conducted under the environmental carcinogenesis program of the National Cancer Institute is directed at discovery and ranking of the contribution of environmental agents (mostly chemical) to the causes of cancer, bioassays on the chemicals and epidemiological studies. The National Istitute of Environmental Health Sciences (NIEHS) links fundamental research, both that conducted at NIH and in universities, with applied environmental problems related to air pollution, water pollution, industrial chemicals and pesticides. Research focuses on biochemical mechanisms by which environmental chemicals affect people and gathering of data necessary to determine dose-response relationships.

The National Institute of Occupational Safety and Health (NIOSH) acts as the research arm of the Occupational Safety and Health Administration located in the Labor Department. It conducts and supports research on biological effects on people of industrial hazards to provide the Labor Department with recommendations for setting of standards.

The Food and Drug Administration (FDA) conducts research to devise and improve chemical and instrumental analytical methods, biological assay methods, methodology to detect hazardous or potentially harmful biological products, microbiological testing procedures and rapid-screening methods to detect animal drug residues in foods. Toxicological reviews are made on foods, colors and animal seed additives, chemicals, cosmetics and drugs. Studies are also conducted on the bioeffects of light and sonic radiation.

EPA/ORD provides partial support to the National Center for Toxicological Research (NCTR) for research on the long-term effects of low levels of chemical toxicants. ORD has developed working agreements with DHEW (NIOSH, NIEHS) to do health effects research, especially for pollutants associated with increasing energy production. In FY 1976, EPA will transfer $5.5 million to DHEW to study human health effects of air, water and multiroute exposure to pollutants associated with energy development. DHEW will also develop instrumentation and devices for measurement of hazardous agents associated with energy usage in occupational environments. EPA/ORD research with environmental carcinogens is done in cooperation with DHEW. Also, in cooperations with the Communicable Disease Center (CDC), ORD conducts population studies for investigating the health impacts of toxic material emitted from smelters.

Department of Transportation (DOT)

Research by DOT in environmental protection related to transportation will total approximately $18 million in FY 1976. These programs include investigation and testing of ways to reduce noise and decrease adverse effects of noise associated with aircraft and surface transportation. Noise prediction and reduction techniques developed by DOT are used by localities and industry.

Other work is related to development of technical tools to plan for and implement environmental protection associated with transportation systems and facilities. This includes highways and airports operations, controlling stream sedimentation (erosion) and oil spills and other pollution at sea.

An assessment of possible climatic changes produced by disturbing the upper atmosphere by stratospheric air travel and other flight operations will be continued.

DOT is supported by EPA/ORD in the Regional Air Pollution Study in St. Louis and jointly funds a study of health costs associated with automobile-related air pollution. ORD also has an interagency agreement with DOT, HUD, NSF, and CEQ to evaluate costs and effects of alternative patterns of metropolitan development.

Department of Housing and Urban Development (HUD)

In FY 1976, HUD will conduct about $14 million of research and development related to environmental protection.

HUD utility systems research is concerned with encouraging the development and use of more efficient utility systems, including waste management systems, that conserve natural resources and protect the environment.

EPA/ORD has an interagency agreement with HUD, DOT, NSF and CEQ to evaluate the costs and effects of alternative patterns of metropolitan development. Expected funding in FY 1976 is about $100 thousand.

Council on Environmental Quality (CEQ)

Research undertaken by CEQ reflects its nature as an advisory body. The Council staff supervises research that is planned and funded in conjunction with other federal agencies.

The Council's first obligation in environmental research is to weigh issues and draw attention to those which most urgently require improved knowledge to make intelligent decisions. Much of CEQ's research is oriented toward issues perceived as having immediate importance where CEQ can best exercise a policy advisory role. A second important duty is to inspire and coordinate environmental research in neglected areas.

The Council's research efforts, budgeted at less than $1 million for FY 1976, may be grouped into four principal categories--energy, land use, pollution and trends.

ORD works with CEQ in the following areas: energy R&D; study to test the validity of indexes for water quality; development of an air quality index; and study to evaluate costs and effects of alternative patterns of metropolitan development.

Tennessee Valley Authority (TVA)

EPA/ORD provides support to the Tennessee Valley Authority (TVA) primarily for RD&D on reliability and efficiency of sulfur-dioxide control operations.

In addition to the substantial flue gas desulfurization test program at Shawnee, work with TVA also involves: (1) assessment of water and waste streams from coal-fired power plants, (2) ash disposal problems, (3) coal-pile drainage problems, (4) characterization of air pollutants for toxic, carcinogenic and mutagenic materials, (5) thermal pollution control by application and evaluation of wet and dry cooling tower technology, and (6) economic modeling to assess an area's sensitivity to various national parameters and to evaluate the impact of expanding energy-generating systems on population, labor force, employment, etc.

In FY 1976, EPA will transfer $1.5 million to the TVA to study effects of energy-related atmospheric pollutants on terrestrial ecosystems, primarily in the Southeastern U.S. and to study effects of waterborne pollutants from steam-electric power generation.